Health Consultation

Public Health Implications of Residential Exposures to Contaminated Soil

Sherwin-Williams/Hilliards Creek Site
United States Avenue Burn Site
Route 561 Dump Site

Gibbsboro and Voorhees Township, Camden County, New Jersey

EPA FACILITY ID: NJD980417976
EPA FACILITY ID: NJ0001120799
EPA FACILITY ID: NJ0000453514

Prepared by:
New Jersey Department of Health

July 21, 2023

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Office of Capacity Development and Applied Prevention Science
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Summary

Introduction

In 2009, the New Jersey Department of Health (NJDOH) prepared a public health assessment for the Sherwin-Williams/Hilliards Creek sites in Gibbsboro and Voorhees, Camden County, New Jersey. This document was prepared under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). The public health assessment recommended that Sherwin-Williams continue to characterize the extent of contamination on and off the site. This included collecting soil samples on residential properties near the site. The public health assessment also stated that NJDOH would evaluate any additional data for public health implications.

Three sites make up what is commonly referred to as the "Sherwin-Williams sites." These sites include the former Sherwin-Williams manufacturing facility and Hilliards Creek (Sherwin-Williams/ Hilliards Creek Superfund Site) and two nearby sites where Sherwin-Williams dumped wastes from the manufacturing plant. These dump sites are known as the United States Avenue Burn Site and the Route 561 Dump Site. Contaminated soils and sediments have migrated from these sites onto nearby residential properties.

This health consultation evaluates the public health implications of exposures to soil contaminants that migrated from the Sherwin-Williams sites onto 61 nearby residential properties. The nearby Gibbsboro Elementary School is also included in this evaluation. The primary site contaminants in soil are lead, arsenic, copper, and polycyclic aromatic hydrocarbons (PAHs).

The residential properties are grouped as follows: Groups A, B, C, D, and E. The United States Environmental Protection Agency (USEPA) removed contaminants from (remediated) two properties in Group A (properties A-1 and A-3). Property A-2 had no contamination, so no action was needed. Properties in Group E are not planned for remediation based on USEPA's evaluation of these properties. Properties in Groups B, C, and D have been remediated, except for three properties in Group C. One of these properties is vacant. The other two have contamination in the floodplain behind the homes on Gibbsboro public property, which will be remediated as part of a different cleanup phase: USEPA's fourth operable unit (OU-4).

Recent information from USEPA indicates that most of the contamination associated with properties in Groups C and D was located along the floodplain area south of the property boundaries and not on the properties themselves. NJDOH and ATSDR acknowledge this new information and that exposures to contaminants might be overestimated in this evaluation.

NJDOH and ATSDR assumed a conservative residential scenario for all properties to account for the possibility that children might have accessed the floodplain area behind their homes at some point in the past. ATSDR and NJDOH acknowledge that these areas are not easily accessible for current and future exposures and will be remediated in the near future as part of the OU-4 cleanup phase.

The top priority of NJDOH and ATSDR is to ensure that the communities around the sites have the best information possible to safeguard their health. Fact sheets on reducing exposures to soil contaminants can be found in **Appendix E** of this document.

Conclusions

NJDOH and ATSDR have reached the following conclusions for residential exposures to surface soil contaminants from the Sherwin-Williams/Hilliards Creek site:

Conclusion 1

Current and future exposures to copper and lead in surface soil at three of the 61 residential properties might harm peoples' health.

Basis for Conclusion

Children residing at properties D-4 and D-13 who have soil-pica behavior (eating unusually high amounts of soil) might experience gastrointestinal effects (nausea, stomach pain, vomiting) from exposures to copper in soil. Properties D-4 and D-13 contain levels of copper that result in an elevated noncancer hazard based on the conservative soil-pica pathway. The maximum concentrations of copper used to estimate pica hazard on these properties (i.e., 385 mg/kg on D-4 and 124 mg/kg on D-13) are an order of magnitude below the current New Jersey Department of Environmental Protection (NJDEP) residential soil remediation standard of 3,100 mg/kg. Therefore, these properties were not selected for remediation.

Based on three soil samples, property E-10 had average soil lead levels above 200 mg/kg. This is the level at which USEPA's lead model predicts children's blood lead levels could exceed a target of 5 µg/dL, which is used to determine if subsequent remediation is necessary.

Although property E-10 has elevated levels of lead, the lead at this property is not considered to be site related. Therefore, this property was not selected for remediation. Exposures to elevated lead levels in soil should be minimized as much as possible. Higher blood lead levels in children may result in attention, learning and behavioral problems. They also might cause decreased hearing and slower growth and development.

Next Steps	NJDOH and ATSDR recommend that residents with young children at properties D-4, D-13, and E-10 take measures to reduce exposures to copper and lead in soil. NJDOH has provided information to residents at properties D-4, D-13, and E-10 to ensure that they have the knowledge to protect their health by reducing and/or preventing exposures to soil contaminants. (See Fact Sheets in **Appendix E**.) NJDOH and ATSDR recommend that residents tell their health care provider if they have been exposed to contaminants under the conditions described in this report. A health care provider can help residents determine whether they need special medical evaluation or increased frequency of tests.

Conclusion 2	*Past exposures to arsenic, copper, and lead in surface soil at 27 of the 61 residential properties might have harmed peoples' health.*
Basis for Conclusion	The floodplain area of Hilliards Creek, which is owned by the borough, is contaminated. Children with above average soil ingestion rates who frequently accessed that area behind properties C-1 and C-4 might have experienced dermal effects (darkening and thickening of skin) from arsenic exposure. Residents at property C-4 might have experienced facial swelling and gastrointestinal effects from acute (short-term) exposures to arsenic in soil. This is because calculated exposure doses approached or exceeded levels where these health effects were seen in human toxicological studies. Children with above average soil ingestion rates living at properties B-8 and C-7 might have experienced gastrointestinal effects (nausea, stomach pain, vomiting) from copper exposure. This is because calculated exposure doses exceeded levels where these effects were seen in toxicological (human) studies. Children who might have soil-pica behaviors (eating unusually high amounts of soil) living at 14 of these properties might have experienced gastrointestinal health effects from copper exposure. This is because calculated exposure doses exceeded levels where these effects were seen in toxicological studies. Additionally, 23 of these properties had average soil lead levels above 200 mg/kg. This is the level at which USEPA's lead model predicts children's blood lead levels could exceed a target of 5 µg/dL, which is used to determine if subsequent remediation is necessary. Higher blood lead levels

in children can result in attention, learning and behavioral problems. They also might cause decreased hearing and slower growth and development.

Arsenic levels in surface soil at seven properties might result in an increased theoretical cancer risk from exposure. Arsenic levels combined with elevated levels of PAHs may result in an increased theoretical cancer risk at property C-8.

These 27 properties have been remediated in accordance with USEPA's September 2015 Record of Decision. This minimizes or stops current and future exposures at these properties. Contamination located within the sediments and floodplain soils of Hilliards Creek, which is behind properties C-1 and C-4, will be remediated as part of USEPA's OU-4. The contamination behind properties C-1 and C-4 is not easily accessible. USEPA has informed residents of the contamination and asked that residents avoid these areas. Property C-3 is vacant and will be remediated as part of OU-4.

Next Steps

The NJDOH and ATSDR recommend that the USEPA continue remediation of the site as described in the September 2021 Record of Decision for Operable Unit 4.

Conclusion 3

Past, current, and future exposures to surface soil contaminants at 32 properties, including the Group A properties and the Gibbsboro Elementary School, are not likely to harm people's health.

Basis for Conclusion

Six properties had elevated hazard quotients[1], but health effects are not likely based on available toxicological information. The remaining 26 properties did not have elevated hazard quotients. All 32 properties had average surface soil lead levels below 200 mg/kg. All 32 properties also had low cancer risks.

For More Information

Copies of this report will be made available at the Gibbsboro and Voorhees Township libraries and the Internet. Questions about this health consultation should be directed to the NJDOH at (609) 826-4984.

[1] The ratio of estimated site-specific exposure to a single chemical in a particular medium from a site over a specified period to the estimated daily exposure level at which no adverse noncancer health effects are likely to occur. NJDOH and ATSDR evaluated all properties with elevated hazard quotients to determine the likelihood of harmful noncancer health effects. Properties where hazard quotients were not elevated indicate that harmful noncancer health effects are not expected.

Statement of Issues

In April 2006, the United States Environmental Protection Agency (USEPA) proposed to add the Sherwin-Williams/Hilliards Creek site to the National Priorities List (NPL). As required by the 1986 Superfund Amendments and Reauthorization Act (SARA) to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, the Agency for Toxic Substances and Disease Registry (ATSDR) is mandated to conduct public health assessment activities for each site listed or proposed to be added to the NPL. The site was listed to the NPL in 2008.

In August 2009, the New Jersey Department of Health (NJDOH) prepared a public health assessment for the Sherwin-Williams/Hilliards Creek site located in Gibbsboro and Voorhees, Camden County, New Jersey **(**see **Appendix A, Figure 1).** This document was prepared under a cooperative agreement with ATSDR [NJDOH 2009]. The public health assessment recommended that Sherwin-Williams continue to characterize the extent of contamination on and off the site. This included collecting soil samples on residential properties near the site. The health assessment also stated that NJDOH would evaluate any additional data for public health implications.

Three sites make up what is commonly referred to as the “Sherwin-Williams sites.” These sites include the former Sherwin-Williams manufacturing facility and Hilliards Creek (Sherwin-Williams/Hilliards Creek Superfund Site) and two nearby sites where Sherwin-Williams dumped wastes from the manufacturing plant. These dump sites are known as the United States Avenue Burn Superfund Site and the Route 561 Dump Site. Contaminated soils and sediments have migrated from these sites onto nearby residential properties.

This health consultation evaluates the public health implications of exposures to soil contaminants that migrated from the Sherwin-Williams sites onto nearby residential properties. The primary site contaminants in soil are lead, arsenic, copper, and polycyclic aromatic hydrocarbons (PAHs).

Background and Site History

The Sherwin-Williams sites are located in a residential and commercial area of Gibbsboro and Voorhees, Camden County, New Jersey. Hilliards Creek flows southwesterly through the former facility, under Foster Avenue, then turns west under West Clementon Road, receives the outflow of Bridgewood Lake and continues west to Kirkwood Lake (see **Appendix A, Figure 2**).

Sherwin-Williams manufactured lead paints, varnishes, and lacquer at the facility, which operated from 1849 to 1977. Raw materials included lead oxide, zinc oxide, lead chromate, ferrous sulfate, sulfuric acid, linseed oil, and various solvents. The raw materials were mixed and processed in specialized buildings within the facility. Manufacturing operations ended at the facility in late 1976 and early 1977 [NJDOH 2009].

In 1981, the property was sold to a private developer. Development of the property included demolition or renovation of existing structures; construction of new office, manufacturing, and warehouse spaces; and re-grading of adjacent areas. While the property was being reconfigured, contractors found an “oily substance” seeping out of the ground. Investigations into the source of the pollution revealed hazardous substances in the groundwater beneath the former facility and in soil surrounding the structures at the plant. The buildings are currently vacant, have been demolished, or are being used for offices and light industrial operations.

Wastes generated from the Sherwin-Williams plant were disposed of in Hilliards Creek, the Route 561 Dump Site, and the United States Avenue Burn Site (see **Appendix A, Figure 2**). The United States Avenue Burn Site and Route 561 Dump Site have been listed and proposed to be listed on the NPL as separate sites, respectively.

Environmental Investigations for the Residential Properties

The data evaluated in this health consultation includes results of soil samples collected from 61 residential properties and from the nearby Gibbsboro Elementary School located near the former Sherwin-Williams site. The school was sampled after concerns were raised during the public comment period for the USEPA’s proposed plan, which described the selected remedy for cleaning up the contaminated soil on the residential properties [USEPA 2015a].

USEPA and Sherwin-Williams conducted several phases of soil sampling between 1991 and 2015, under USEPA oversight. Soil sampling was conducted on 54 residential properties during USEPA’s Remedial Investigation [Weston 2015]. The remaining seven properties were sampled before or since the remedial investigation activities. Residential properties located within the floodplain of one of the affected waterways or immediately next to one of the sites were selected for sampling.

Based on USEPA’s evaluation of the soil sampling results, residential properties are categorized as follows:

a) No remedial action (removal of contaminants) is anticipated
b) Remedial action is required
c) Additional soil sampling is required to determine the extent and/or need for remediation

Soil samples collected from the residential properties were analyzed for the following contaminants:

- Metals,
- Volatile organic compounds (VOCs),
- Semi-volatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs)
- Pesticides
- Polychlorinated biphenyls (PCBs)

Lead and arsenic were found most frequently at levels above the New Jersey Department of Environmental Protection (NJDEP) residential soil remediation standards at the sites and residential properties. PAHs were also found above the NJDEP soil remediation standards at the sites and residential properties, but less frequently.

Contaminated sediments from Hilliards Creek and Kirkwood Lake could be deposited within the floodplains of the residential properties along these two water bodies. Contamination is generally found in shallow soils on residential properties along Hilliards Creek and Kirkwood Lake.

In September 2015, USEPA issued a Record of Decision to address contaminated soils on residential properties impacted by the Sherwin-Williams sites. The remedy selected by USEPA was to excavate and remove contaminated soil from properties exceeding the applicable cleanup criteria for that contaminant. The excavated areas would be backfilled with clean soil and restored [USEPA 2015b].

In accordance with ATSDR guidance, only surface soil samples were used to evaluate the potential for health effects. This is because subsurface soils are not routinely accessible. For surface soil, ATSDR considers the top three inches of soil to be the layer for incidental soil ingestion and skin contact exposures. The surface soil data evaluated in this health consultation were collected at a depth of 0-0.5 feet below ground surface (bgs). These data were used to evaluate the potential for health effects.

The residential properties were grouped as shown in **Table 1.** See **Appendix A, Figures 3 and 4** for the property locations. This health consultation evaluates soil contaminants on 61 residential properties and the nearby Gibbsboro Elementary School.

Table 1. Residential Property Groups and Locations

Property Group	Property Identification	Number of Properties	Sample Dates	Property Location	Remediation Status
A	A-1 through A-3	3	July 2005; June-August 2007	Adjacent to United States Avenue Burn Site or Route 561 Dump Site	Completed or Not Needed
B	B-1 through B-8	8	October 2008; November 2010; February-March 2011	Adjacent to the Sherwin-Williams Former Manufacturing Plant	Completed
C	C-1 through C-13 and C-19	14	November 1999-January 2000; July and November 2007, September 2001 and November 2001	Hilliards Creek Floodplain	Planned, Completed, or Not Needed
D	D-1 through D-31	31	June 2002, August and December 2003*; June-August 2011	Kirkwood Lake floodplain	Completed or Not Needed
E	E-7 through E-11	5	December 2015	Adjacent to the Sherwin-Williams Former Manufacturing Plant	Not Planned, or Not Needed

*These samples were collected as part of USEPA removal actions at these properties; remaining samples were collected as part of various remedial investigations for the Sherwin-Williams sites.

Gibbsboro Elementary School – In March 2016, 24 surface soil samples (0-0.5 feet bgs) were collected on the school property. Samples were analyzed for metals. Remedial actions are not planned for the school property based on the sample results. No contaminants exceeded applicable cleanup criteria. In April 2016, USEPA provided copies of the sampling results to the school superintendent and to the mayor of Gibbsboro.

Demographics and Pica Considerations

According to the 2010 United States Census data, ATSDR estimates that about 6,900 people live within a 1-mile radius of the Sherwin-Williams/Hilliards Creek site. Of these, 438 are children ages 6 and younger (**See Appendix B**). This is important because the primary contaminant of concern is lead, which can be toxic to young children, especially those under age 6. This is also significant because of potential soil-pica behaviors in young children. Pica is defined as the consumption of nonfood items and is well documented in children [ATSDR 2018]. Soil-pica is the consumption of large amounts of soil. Several risk factors are associated with increased blood lead levels in children. These include:

- living in homes built before 1978, and especially before 1950,
- age of infrastructure (i.e., plumbing),
- living in rental housing,
- poverty,
- minority groups,
- living in the Northeast region of the United States, and
- immigrant and refugee populations.

Having one or more of these risk factors means that children have a greater risk for having increased blood lead levels.

The Gibbsboro Elementary School is the closest school to the site. Sherwin-Williams sampled the soil on the school property under USEPA oversight. The closest childcare center is called “Little Angels Academy.” The childcare center was not sampled as part of the remedial investigation for the Sherwin-Williams sites; however, this daycare center has been evaluated by NJDEP and NJDOH as part of New Jersey’s Child Care Safe Siting Program.

NJDOH investigated the childcare facility and issued an approval for the center in September 2012. This approval was based on a review of information provided to NJDOH, including a preliminary assessment report and childcare center approval letter from NJDEP. NJDOH conducted a site visit along with a review of historical uses of the building and any nearby contaminated sites. There is no evidence of any impacts to the center from the Sherwin-Williams sites. NJDOH continues to review current information when the childcare center license is up for renewal.

Past ATSDR/NJDOH Involvement

In 1999, ATSDR and NJDOH prepared a health consultation for Hilliards Creek [ATSDR 1999]. ATSDR and NJDOH evaluated analytical data showing that lead was detected at 221,900 mg/kg in a sediment sample collected in the Hilliards Creek Wildlife Refuge in 1998.

ATSDR and NJDOH concluded that an urgent health hazard existed for children and adults who used the refuge. The area where the sediment sample was collected was expected to be visited frequently because a trail in the refuge brought visitors to the sampling location. In response to this, USEPA required Sherwin-Williams to determine how much contamination was located in accessible areas along Hilliard's Creek. This included posting signs and installing fences to prevent access and conducting quarterly site inspections.

ATSDR and NJDOH have completed two health consultations and one public health assessment for the United States Avenue Burn and the Route 561 Dump sites [ATSDR 2000]. Two previous data reviews also were completed for the sites.

August 2009 - Public Health Assessment

The 2009 public health assessment evaluated all potential exposure pathways from the site based on available data. This evaluation focused on site soil and groundwater, Hilliards Creek soil and sediment, and surface water. A brief description of the findings follows:

- Past exposures to lead associated with the sediment and floodplain soils of Hilliards Creek might have harmed people's health. Exposures were partially interrupted through removal of contaminated soil from an area along United States Avenue, one residence on Kirkwood Road, and by installing partial fencing around the contaminated area north of Hilliards Creek.

- NJDOH and ATSDR could not conclude whether past or current exposures to potable water, indoor air and consumption of plants, fish, and game from the Sherwin-Williams/Hilliards Creek site might have harmed people's health. These data were not available at the time the public health assessment was prepared.

- NJDOH and ATSDR could not conclude whether current exposures to soil and sediment at the Sherwin-Williams/Hilliards Creek site could harm people's health. Although Sherwin-Williams took interim remedial measures to address some on-site contamination, characterization and delineation of on- and off-site areas had not been completed.

- Blood lead levels measured in Gibbsboro children were similar to statewide average levels.

The public health assessment recommended that Sherwin-Williams, with USEPA oversight, complete the remedial investigation and remediation of on-and off-site areas including the residential properties as soon as feasible. The public health action plan stated separate health consultations would be done as additional data became available. In December 2010, NJDOH prepared a health consultation evaluating additional data per the recommendations in the public health action plan.

December 2010 - Health Consultation evaluating vapor intrusion and potable well data

The 2010 health consultation was prepared to evaluate additional data that became available after completion of the 2009 public health assessment and in response to the public health action plan. The conclusions from this health consultation are as follows:

- Off-site potable wells are not affected by site-related contamination; therefore, there is no harm to people's health. Tests of water samples collected from potable wells did not detect site-related contaminants.

- Exposures to potential indoor air contaminants at residences and the on-site buildings are not expected to harm people's health.

Scientific Evaluation

ATSDR uses a standard method for assessing whether a community is at risk for a health hazard. The first step is to determine whether there is a completed exposure pathway from a contaminant source to an exposed population, and screening contaminants against comparison values to determine contaminants of concern. The next question is whether the exposures to contamination are high enough to be of health concern [ATSDR 2005]. Site-specific exposure doses can be calculated and compared with health guideline values. Health guideline values are not available for lead. Therefore, lead exposure doses cannot be calculated using this approach. Instead, lead is evaluated using USEPA’s integrated exposure uptake biokinetic (IEUBK) model [USEPA 2021a].

Exposure Pathway Analysis

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending with contact with the human body. A completed exposure pathway has five elements:

1) Source of contamination (Sherwin-Williams sites)
2) Environmental media and transport mechanisms (soil)
3) Point of exposure (residential yards/floodplain area behind homes)
4) Route of exposure (ingestion)
5) Receptor population (residents)

Generally, ATSDR considers three exposure pathway categories:

1) Completed exposure pathways — all five elements of a pathway are present

2) Potential exposure pathways — one or more of the elements might not be present, but information is insufficient to eliminate or exclude the element

3) Eliminated exposure pathways — one or more of the elements is absent

Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

Completed Exposure Pathways

Ingestion of and dermal contact with contaminated surface soils (past, current, and future). For the past, there is a completed exposure pathway for ingestion of and dermal contact with contaminated surface soil (0-0.5 feet bgs) for residents living near the Sherwin-Williams sites or the floodplains of Hilliards Creek or Kirkwood Lake. These residents, especially children, might have ingested contaminated soil on their property.

Properties in Groups A, B, C, and D with elevated levels of site-related contaminants based on USEPA's cleanup criteria have been remediated as part of USEPA's September 2015 Record of Decision. The remediation of these properties minimizes current and future exposures to contaminated soil.

Properties C-1 and C-4 have contamination behind their property boundaries in the Hilliard's Creek floodplain area. Property C-3 is vacant. This contamination will be remediated as part of the Hilliard's Creek area known as "Operable Unit 4 [USEPA 2021b]." Some properties that were sampled did not have any contaminants exceeding the NJDEP RSRS. Therefore, there are no remediation activities planned for those properties. The NJDOH is evaluating potential exposures at all properties, regardless of remediation status.

Public Health Implications of Completed Exposure Pathways

After determining that people have or are likely to contact site-related contaminants (i.e., a completed exposure pathway), the next step in the public health assessment process is to calculate site-specific exposure doses. This is called a health guideline comparison. It involves looking more closely at site-specific exposure conditions, the estimation of exposure doses, and the evaluation with health guideline values. Health guideline values are based on data drawn from the epidemiologic and toxicologic literature. These guidelines often include uncertainty or safety factors to ensure that they are amply protective of human health.

Exposure doses are not calculated for lead. The Centers for Disease Control and Prevention (CDC) currently uses a blood lead reference value of 3.5 micrograms of lead per deciliter of blood (µg/dL) to identify children with higher levels of lead in their blood compared to 95% of children ages 1-5 years old living in the US.

Residential child lead exposures are evaluated using USEPA's IEUBK model [USEPA 1994, 2021]. This model is designed to predict the probability that children ages 1-5 years who regularly play in areas with soil lead contamination could be exposed to lead at levels high enough to raise their blood lead levels above 5 µg/dL. CDC previously used 5 µg/dL as its blood lead reference value; it is the lowest blood lead level verified for the model. This probability estimate should be at or below a protection level of five percent, as recommended by the USEPA Office of Solid Waste and Emergency Response (USEPA 1994). In other words, USEPA's goal is that a typical child or group of similarly exposed children should have an "estimated risk" of no more than 5% of exceeding a blood lead level of 5µg/dL. USEPA guidance states that average soil lead concentrations should be used when running the model [USEPA 1994]. Because a safe blood lead level has not been identified, it is important to reduce lead exposure as much as possible.

USEPA Region 2 uses a lead concentration of 200 mg/kg as a screening level to determine whether an additional property-specific risk evaluation is needed. If the average lead concentration in the top 2 feet of soil exceeds this screening level, the IEUBK model is used to quantify lead exposures and characterize risk. When risks above USEPA thresholds are identified using this model, remediation is performed. Those areas with lead levels exceeding the current NJDEP RSRS of 400 mg/kg are targeted for cleanup. Additional excavations are done as needed to ensure the resulting post-remedy property average is at or below 200 mg/kg.

Screening Analysis

Maximum concentrations of detected substances are compared with media-specific comparison values (CVs) for screening contaminants. If concentrations exceed the CV, these substances, referred to as potential contaminants of concern, are selected for further evaluation. Contaminants without CVs are also selected.

Contaminant levels above CVs do not mean that adverse health effects are likely, but that a health guideline comparison is necessary to evaluate site-specific exposures [ATSDR PHAGM 2022]. See **Appendix C** for a detailed description of the ATSDR health assessment process.

Comparison Values

A number of CVs are available for screening contaminants to identify potential contaminants of concern. These include ATSDR environmental media evaluation guides (EMEGs) and reference media evaluation guides (RMEGs). EMEGs are based on ATSDR's minimal risk levels and are estimated contaminant concentrations in water or soil that are not expected to result in adverse noncarcinogenic health effects. RMEGs are based on EPA's reference doses and represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

If the substance is a known or a probable carcinogen and has cancer toxicity values, ATSDR's cancer risk evaluation guides (CREGs) were also considered as comparison values. CREGs are estimated contaminant concentrations in soil or water that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed during their lifetime (78 years).

In the absence of an ATSDR CV, other screening levels, such as USEPA's regional screening levels (RSLs), can be used to screen contaminant levels in environmental media. RSLs are contaminant concentrations corresponding to a fixed level of risk (i.e., a hazard quotient[2] of 1, or lifetime excess cancer risk of one in one million, whichever results in a lower contaminant concentration) in water, air, biota, and soil. For soils and sediments, other screening levels

[2]The ratio of estimated site-specific exposure to a single chemical in a particular medium from a site over a specified period to the estimated daily exposure level at which no adverse health effects are likely to occur.

include the NJDEP Residential Soil Remediation Standards (RSRS). These criteria are health-based and may account for natural background concentrations, analytical detection limits, and ecological effects.

Table 2 summarizes the various CVs and other screening levels used to screen for potential contaminants of concern. Substances exceeding CVs were identified as potential contaminants of concern and evaluated further to determine whether these contaminants pose a health threat to exposed or potentially exposed populations. **Tables A-1 through A-6 in Appendix A** summarize the potential contaminants of concern for each property group that were selected for further evaluation for possible health effects.

Table 2. Comparison Values or Screening Levels

Comparison Value/Screening Level	Acronym	Source
Environmental Media Evaluation Guide	EMEG	ATSDR
Reference Media Evaluation Guide	RMEG	ATSDR
Cancer Risk Evaluation Guide	CREG	ATSDR
Residential Soil Remediation Standard	RSRS	NJDEP
Regional Screening Level	RSL	USEPA

Abbreviations: ATSDR = Agency for Toxic Substances and Disease Registry; NJDEP = New Jersey Department of Environmental Protection; USEPA = United States Environmental Protection Agency.

Hexavalent Chromium

Hexavalent chromium is a more toxic form of chromium. NJDOH does not have data for hexavalent chromium on the residential properties. NJDOH has data for total chromium, which is a mixture of hexavalent and trivalent chromium. To determine if hexavalent chromium might be present on the residential properties, NJDOH looked at the human health risk assessments for the United States Avenue Burn site [Gradient 2016] and the Sherwin-Williams former manufacturing plant site [Gradient 2017], which have hexavalent chromium data for surface soil.

Hexavalent chromium was present at low levels on both sites. Of the 15 surface soil samples (0-0.5 feet bgs) collected on the United States Avenue Burn site in the 1990s, only two samples had detections of hexavalent chromium. The maximum hexavalent chromium concentration in surface soil was 43.7 milligrams per kilogram of soil (mg/kg). We don't have corresponding total chromium data to determine the percent contribution of hexavalent chromium to total chromium.

NJDOH used more recent hexavalent chromium data collected for the former Sherwin-Williams manufacturing plant site in 2016 to determine how much hexavalent chromium could be present on the site properties. We calculated the percentage of hexavalent chromium to total chromium to determine how much hexavalent chromium could be on the Sherwin-Williams site that could migrate onto the residential properties.

In September and October 2016, 45 surface soil samples were collected on the Sherwin-Williams site property. Of these, 18 had detectable levels of hexavalent chromium. We calculated the percent of hexavalent chromium to total chromium. The average hexavalent chromium contribution to total chromium was only 6%. Therefore, it is unlikely that hexavalent chromium would be found at significant levels on the residential properties. Based on this information, the trivalent form of chromium was used to screen for potential health effects for the residential properties[3].

Determining the Exposure Concentration for Contaminants of Concern

When assessing the public health implications of exposure to a contaminant of concern, ATSDR recommends using the 95% upper confidence limit (UCL) of the arithmetic mean to determine the exposure point concentration (EPC) for site-related contaminants [ATSDR 2019]. The 95% UCL is considered a "conservative estimate" of average contaminant concentrations in an environmental medium.

EPCs were calculated for each contaminant at each property for all contaminants of concern. Using ATSDR guidance, the 95% UCL was used for soil contaminants with at least eight samples and for samples with at least 20% detections [ATSDR 2019]. Maximum concentrations were used as the EPCs for contaminants with less than eight samples or less than 20% of detections. Maximum concentrations were also conservatively used as the EPC for the soil-pica pathways. For some datasets, other statistics (mean, 97.5% UCL, or 99% UCL) were more appropriate for the EPC. The arithmetic mean was used as the EPC for lead. This is because EPA recommends using the mean as the preferred measure of lead in soil for the IEUBK model.

Noncancer Health Effects

To assess noncancer health effects, ATSDR has developed minimal risk levels (MRLs) for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk for adverse, noncancer health effects. MRLs are developed for a route of exposure, such as swallowing or breathing, over a specified period. Exposure periods are classified as:

- acute (less than 14 days),
- intermediate (15 – 364 days), or
- chronic (365 days or more).

MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from effect levels reported in animal toxicological studies or human epidemiological studies. They are adjusted using a series of uncertainty (or safety) factors or through statistical models. In toxicological literature, observed effect levels include:

[3] To further support the decision to use the trivalent form of chromium, NJDOH took 6% of total chromium values on the property with the highest total chromium concentration. NJDOH calculated the 95% upper confidence limit (UCL) to determine the possible contribution of hexavalent chromium for this property. We evaluated this value for cancer and noncancer health effects using ATSDR's Public Health Assessment Site Tool (PHAST). Using this worst-case scenario, noncancer health effects would not be expected, and theoretical cancer risks are low for children and adults. Definitions of 95% UCL and PHAST are provided later in the document.

- no-observed-adverse-effect level (NOAEL) and
- lowest-observed-adverse-effect level (LOAEL).

A NOAEL is the highest tested dose of a substance that has been reported to have no harmful health effects on people or animals. A LOAEL is the lowest tested dose of a substance that has been reported to cause harmful health effects in people or animals. Based on current ATSDR guidance, calculated exposure doses are compared to effect levels (LOAELs) rather than no effect levels (NOAELs) when deciding possible health effects. As the exposure dose increases beyond the MRL to the level of the LOAEL, the likelihood of adverse health effects increases.

To ensure that MRLs are sufficiently protective, the extrapolated values can be several hundred times lower than the effect levels reported in experimental studies. When MRLs for specific contaminants are unavailable, other health guidelines, such as the USEPA reference dose (RfD), are used. The RfD is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime.

Ingestion – Residential Soil

Exposures are based on incidental ingestion of contaminated surface soil for children and adult residents. Noncancer exposure doses were calculated using the following formula:

$$\textit{Exposure dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW}$$

where,
mg/kg/day = milligrams of contaminant per kilogram of body weight per day
C = concentration of contaminant in surface soil (mg/kg)
IR = soil ingestion rate (mg/day)
EF = exposure factor representing the site-specific exposure scenario
CF = conversion factor (10^{-6} kg/mg)
BW = body weight (kg).

Noncancer health effects are assessed by comparing the exposure dose to the MRL (or RfD) via a ratio known as the hazard quotient or HQ. The hazard quotient is defined as follows:

$$\textit{Hazard quotient (HQ)} = \frac{\textit{Exposure dose}}{\textit{MRL (or RfD)}}$$

As the hazard quotient exceeds 1.0 and approaches effect levels, the potential for harmful effects increases. Contaminants with a hazard quotient exceeding a value of 1.0 were evaluated further to determine whether these contaminants pose a health threat to exposed or potentially exposed populations. This was done by comparing calculated exposure doses to effect levels reported in toxicological studies.

Exposure Dose Assumptions and Scenarios for Contaminants Other than Lead

ATSDR's exposure dose guidance for soil and sediment ingestion and USEPA's *Exposure Factor Handbook* were used to calculate exposure doses [ATSDR 2018, USEPA 2011]. Exposure doses were calculated for adults and children ingesting contaminated soil on each property.

Exposure doses were calculated for three soil ingestion scenarios using the ATSDR Public Health Assessment Site Tool (PHAST). For people with typical, (average) soil ingestion rates, we used a "central tendency exposure" (CTE) scenario. For people with above average ingestion rates, a "reasonable maximum exposure" (RME) scenario was used. The RME refers to people with above average exposures but still within a realistic exposure range.

For CTE and RME scenarios, the age range for children is from infant through less than 21 years. The adult scenario is for people 21 years of age and older. **Table 3** shows the exposure parameters and assumptions used to calculate exposure doses for both scenarios.

Table 3. Exposure Parameters and Assumptions for Dose Calculations - Soil Ingestion

Age Group	CTE - Average soil ingestion rate (mg/day)	CTE Residential exposure duration (years)	RME - Above average soil ingestion rate (mg/day)	RME Residential exposure duration (years)	Body weight (kg)	Residential exposure frequency (days/year)
Child - Birth to < 1 year	55	12	150	33	7.8	365
Child - 1 to < 2 years	90	12	200	33	11.4	365
Child - 2 to < 6 years	60	12	200	33	17.4	365
Child - 6 to < 11 years	60	12	200	33	31.8	365
Child - 11 to < 16 years	30	12	100	33	56.8	365
Child - 16 to < 21 years	30	12	100	33	71.6	365
Adult ≥ 21 years	30	12	100	33	80	365

CTE = central tendency exposure; RME = reasonable maximum exposure; mg/day = milligrams of soil ingested per day; kg = kilograms.

The third soil ingestion scenario is for children with soil-pica behaviors. Pica is defined as the consumption of nonfood items and is well documented in children [ATSDR 2018]. Soil-pica is the consumption of large amounts of soil. Within any population of children, particularly those of preschool age, some could have soil-pica behavior.

Soil-pica behavior is most likely to occur in preschool children as part of their normal exploratory behavior, with somewhere from 4% to 20% of preschool children having soil-pica behavior. Children between the ages of 1 and 2 years have the greatest tendency for soil-pica behavior, which diminishes as they age [ATSDR 2018]. For this health consultation, soil-pica behavior was assessed for two preschool-aged groups: ages 1 to < 2 years, and 2 to < 6 years.

Table 4 summarizes the parameters used to evaluate soil-pica behavior in children. These parameters represent a weekly dose for acute exposures or a monthly dose for intermediate durations. The soil ingestion rate for pica behavior in children represents the average (CTE) intake rate. There is no reliable upper percentile intake rate available for soil-pica [ATSDR 2018]. NJDOH and ATSDR acknowledge that the pica child scenario uses conservative exposure assumptions. It assumes a child with pica behavior has access to areas with the highest level of soil contamination.

Table 4. Soil Pica Exposure Parameters

Exposed population	Soil ingestion rate pica child (mg/event)	Body weight (kg)	Exposure frequency
Child (age 1 to < 2 years)	5,000 *	11.4	3 days/7days = 0.429
Child (age 2 to < 6 years)	5,000 *	17.4	3 days/7days = 0.429

*Represents average (central tendency exposure) intake rate; mg = milligrams; kg = kilograms

Dermal exposure doses were also calculated using PHAST and added to the ingestion doses to create a combined dose. The dermal dose was minimal compared to the ingestion exposure pathway. Dermal exposures doses were calculated using the following formula:

$$\text{Dermal exposure dose (mg/kg/day)} = \frac{C \times AF \times EF \times CF \times ABS_d \times SA}{BW \times ABS_{GI}}$$

where
mg/kg/day = milligrams of contaminant per kilogram of body weight per day
C = concentration of contaminant in surface soil (mg/kg)
AF = adherence factor to skin (mg/cm^2-event)
EF = exposure factor representing the site-specific exposure scenario (unitless)
CF = conversion factor (10^{-6} kg/mg)
ABS_d = dermal absorption fraction to skin (unitless)
SA = skin surface area available for contact (cm^2)
BW = body weight (kg)
ABS_{GI} = gastrointestinal absorption factor (unitless)

The potential health effects from site-specific exposures are discussed below. **Appendix D** includes example PHAST spreadsheet and dose calculation examples for noncancer health effects.

Noncancer Health Effects – Metals

Table 5 summarizes the health guideline and toxicity values for the metals that had elevated hazard quotients for at least one age group. There are no health guidelines (e.g., an MRL) or effect levels (e.g., LOAEL) for lead; therefore, lead is evaluated separately.

Table 5. Summary of Toxicity Levels and Noncancer Health Effects

Contaminant	Chronic health guideline and toxicity values (mg/kg/day)	Intermediate health guideline and toxicity values (mg/kg/day)	Acute health guideline and toxicity values (mg/kg/day)	Chronic health effects	Intermediate health effects	Acute health effects
Aluminum	1.0 (MRL) 100 (LOAEL)	1.0 (MRL) 26 (NOAEL) 130 (LOAEL)	NA	Decreased grip strength; decreased thermal sensitivity in mice	Neuromotor effects in mice	NA
Antimony	0.0004 (RfD) 0.35 (LOAEL)	0.0006 (MRL) 0.06 (NOAEL) 0.64 (LOAEL)	1.0 (MRL) 99 (NOAEL)	Blood glucose and cholesterol effects	Decreased serum glucose in rats	Liver lesions in mice
Arsenic [+]	0.0003 (MRL) 0.0008 (NOAEL) 0.002 (LOAEL)	NA	0.005 (MRL) 0.05 (LOAEL)	Skin conditions in humans [++]	NA	Facial swelling/ GI effects in humans
Barium	0.2 (MRL) 61 ($BMDL_{05}$)	0.2 (MRL) 65 (NOAEL) 115 (LOAEL)	NA	Nephropathy (kidney damage)	Increased kidney weights in rats	NA
Cadmium	0.0001(MRL) 0.00033 (UCDL)*	0.0005 (MRL) 0.05 (BMDL)	NA	Altered kidney function in humans	Decreased bone density in rats	NA
Copper	NA	0.02 (MRL) 0.05 ($BMDL_{10}$)	0.02 (MRL) 0.05 ($BMDL_{05}$)	NA	GI effects in humans	GI effects in humans
Iron ^	0.7 (RfD) 1.0 (LOAEL)	NA	NA	GI effects in humans	NA	NA
Vanadium	0.005 (RfD)	0.01 (MRL) 0.12 (NOAEL)	NA	NA	Alterations to blood and blood pressure in humans	NA

[+] ATSDR assumes 60% bioavailability when calculating arsenic doses; [++] Specific skin conditions based on human toxicological studies include hyperpigmentation and hyperkeratosis; NOAEL = no observed adverse effect level; LOAEL = lowest observed adverse effect level; *UCDL = urinary cadmium dose level; BMDL = benchmark dose level; ^ USEPA provisional peer reviewed toxicity values (PPRTV) Provisional Peer-Reviewed Toxicity Values (PPRTVs) Gastrointestinal (GI) effects include nausea, vomiting, diarrhea; MRL = minimal risk level; RfD = USEPA reference dose; mg/kg/day = milligram chemical per kilogram body weight per day; NA = not available

A hazard quotient is calculated for each age group and exposure duration (acute, intermediate, chronic) for each potential contaminant of concern where health guideline values are available. Contaminants with hazard quotients above 1.0 were compared to the corresponding LOAEL to determine the likelihood of adverse health effects. For simplicity, only the results of the maximum RME dose are presented. This dose assumes the worst-case scenario. Additionally, contaminants selected for further evaluation not described in this section had hazard quotients below 1. Therefore, adverse noncancer health effects are not expected from exposures to these contaminants in surface soil.

The following metals had elevated hazard quotients for at least one exposure duration and age group: arsenic, copper, cadmium, and iron. As mentioned above, lead is evaluated separately using the IEUBK model (refer to the Lead – Evaluating Health Effects section below).

Arsenic: Sixteen of the 61 residential properties had elevated hazard quotients for arsenic. Two of these properties (C-1 and C-4) have arsenic levels above the chronic LOAEL of 0.002 mg/kg/day for certain skin conditions (dermal effects). Adverse health effects could result from chronic exposures to arsenic at those properties. Skin conditions from chronic arsenic exposure can take many years of exposure to develop [ATSDR 2007a]. Therefore, weighted averages of the highest exposure doses for children up to age 11 years were calculated. These weighted doses were then compared to the chronic LOAEL. Health effects are not expected for properties with weighted average doses equal to or below 0.0008 mg/kg/day (see **Table 6**).

As shown in **Table 6-A**, residents at property C-4 also have a potential for adverse health effects from acute (short-term) exposures. The exposure dose at this property is approaching the acute LOAEL for facial swelling and gastrointestinal effects [ATSDR 2007a].

The arsenic contributing to these elevated estimates of risk for properties C-1 and C-4 is located along the floodplain in an area that is not easily accessible. USEPA has informed the residents of the contamination and suggested avoiding these areas until they are remediated as part of operable unit 4 [USEPA 2021b]. The remaining 45 residential properties and the Gibbsboro Elementary School did not have elevated hazard quotients for any scenario. Therefore, noncancer health effects are not expected from arsenic exposure at those properties**.**

Table 6. Arsenic – Noncancer Health Effects - Chronic Exposures

Property	Arsenic EPC (mg/kg) [a]	Chronic RME dose (mg/kg/day) [b]	Chronic MRL (mg/kg/day) [c]	Chronic hazard quotient [d]	Chronic LOAEL (mg/kg/day) [e]	RME weighted average dose (mg/kg/day) [f]	Potential for health effects
C-1	431	0.0056	0.0003	19	0.002	0.003	**Yes**
C-4	282	0.0036	0.0003	12	0.002	0.002	**Yes**
C-5	112	0.0014	0.0003	4.8	0.002	0.0008	No
C-9	80	0.0010	0.0003	3.5	0.002	Not Calculated	No
D-8	69	0.0009	0.0003	3.0	0.002	Not Calculated	No
C-3	48	0.0006	0.0003	2.1	0.002	Not Calculated	No
D-7	44	0.0006	0.0003	1.9	0.002	Not Calculated	No
C-7	42	0.00054	0.0003	1.8	0.002	Not Calculated	No
D-19	32	0.0004	0.0003	1.4	0.002	Not Calculated	No
C-6	29	0.00037	0.0003	1.2	0.002	Not Calculated	No
D-10	29	0.0004	0.0003	1.2	0.002	Not Calculated	No
D-30	29	0.0004	0.0003	1.2	0.002	Not Calculated	No
D-28	28	0.0004	0.0003	1.2	0.002	Not Calculated	No
D-23	27	0.0004	0.0003	1.2	0.002	Not Calculated	No
D-9	25	0.0003	0.0003	1.1	0.002	Not Calculated	No
D-11	25	0.0003	0.0003	1.1	0.002	Not Calculated	No

[a] EPC = exposure point concentration derived using 95% UCL of the mean or the maximum concentration (for less than eight samples). The 99% UCL was used for properties C-1 and C-7 because this statistical test was a better fit for the datasets. The 97.5% UCL was used for property C-5 because this statistical test was a better fit for the dataset. The mean was used for property C-6 because the UCL exceeded the maximum; [b] RME = reasonable maximum exposure dose representing above average soil ingestion rates for children ages birth to < 1 year; [c] MRL = minimal risk level; [d] Hazard quotient = RME dose/chronic MRL; [e]

LOAEL = lowest observed adverse effect level; [f] Weighted average RME dose represents children ages birth to <11 years; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Table 6-A. Arsenic –Noncancer Health Effects - Acute Exposures

Property	Arsenic EPC (mg/kg) [a]	Acute RME dose (mg/kg/day) [b]	Acute health guideline value (mg/kg/day) [c]	Acute hazard quotient [d]	Potential for health effects
C-1	520	0.0067	MRL = 0.005 LOAEL = 0.05	1.3	**No**
C-4	1,330	0.0170	MRL = 0.005 LOAEL = 0.05	3.4	**Yes**

[a] EPC = exposure point concentration derived using the maximum concentration; [b] RME = reasonable maximum exposure dose representing above average soil ingestion rates for children ages birth to < 1 year; [c] MRL = minimal risk level; LOAEL = lowest observed adverse effect level; [d] Hazard quotient = acute RME dose/acute MRL; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Copper: ATSDR has an acute and intermediate oral MRL of 0.02 mg/kg/day. This MRL is based on a $BMDL_{10}$ of 0.05 mg/kg/day with an uncertainty factor of 3. There is no chronic MRL for copper. This is because many studies reported that a one-time (acute) exposure to copper near the BMDL resulted in gastrointestinal distress [ATSDR 2022a].

Two properties had elevated hazard quotients for copper. This means that site-specific doses exceeded 0.02 mg/kg/day, putting residents at risk for gastrointestinal distress from copper exposure. Remediation activities at these properties have been completed. Residents at these properties might have experienced health effects such as nausea, abdominal pain, and vomiting from short-term (weekly) exposures to copper in soil in the past. This is because the calculated exposure doses at these properties approached or exceeded the $BMDL_{10}$ of 0.05 mg/kg/day for gastrointestinal effects reported in toxicological studies [ATSDR 2022a] (see **Table 7**). The remaining properties did not have elevated hazard quotients for any exposure scenario; therefore, noncancer health effects would be unlikely.

Table 7. Copper - Noncancer Health Effects - Acute Exposures

Property	Copper EPC (mg/kg) [a]	Acute RME dose (mg/kg/day) [b]	Acute health guideline value (mg/kg/day) [c]	Acute RME hazard quotient [d]	Potential for health effects
B-8	14,400	0.29	MRL = 0.02 $BMDL_{10}$ = 0.05	15	**Yes**
C-7	15,100	0.30	MRL = 0.02 $BMDL_{10}$ = 0.05	15	**Yes**

[a] EPC = exposure point concentration derived using the maximum concentration; [b] RME = reasonable maximum exposure dose representing above average soil ingestion rates for children ages birth to < 1 year; [c] MRL = minimal risk level; BMDL = Benchmark dose level; ; [d] Hazard quotient = Acute RME dose/acute MRL; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Cadmium: One property had elevated hazard quotients for chronic exposures to cadmium for at least one age group. As shown in **Table 8**, the calculated exposure dose is only slightly above the chronic MRL and is well below effect levels. Therefore, adverse noncancer health effects are not likely from exposures to cadmium at this property. The remaining properties did not have elevated hazard quotients for any exposure scenario and therefore, noncancer health effects would be unlikely from exposure to cadmium.

Table 8. Cadmium - Noncancer Health Effects - Chronic Exposures

Property	Cadmium EPC (mg/kg) [a]	Chronic RME dose (mg/kg-day)[b]	Chronic health guideline value (mg/kg/day) [c]	Chronic RME hazard quotient [d]	Potential for health effects
B-7	5.3	0.00011	MRL = 0.0001 LOAEL = 0.00033)*	1.1	No

[a] EPC = exposure point concentration derived using 95% UCL of the mean concentration; [b] RME = reasonable maximum exposure dose representing above average soil ingestion rates for children ages birth to < 1 year; [c] MRL = minimal risk level; LOAEL = lowest observed adverse effect level; [d] Hazard quotient = chronic RME dose/MRL; *This LOAEL represents a urinary cadmium dose level for altered kidney function in humans; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Iron: Iron is an essential nutrient. It is naturally occurring and is not a site-related contaminant [Weston 2015]. According to NJDEP, the average iron concentration in New Jersey soils is 15,860 mg/kg [NJDEP 2020]. The average iron levels at the site are typical for New Jersey soils.

One property (D-19) had an elevated hazard quotient for iron in soil, using the maximum concentration of iron detected in soil. This maximum concentration was used to calculate the hazard quotient due to the small number of samples collected at this property. The maximum concentration appears to be an outlier. It might overestimate the chronic dose and the likelihood of adverse health effects. The average concentration better represents potential exposures at this property.

In the absence of a chronic oral ATSDR MRL, the USEPA oral reference dose was used as a health guideline value. The reference dose for iron is based on a USEPA Provisional Peer Reviewed Toxicity Value (PPRTV) [USEPA 2006]. A PPRTV is derived for use in the USEPA Superfund program when a value is not available in USEPA's Integrated Risk Information System.

All PPRTVs receive internal review by USEPA scientists and external peer review by independent scientific experts. These values do not receive the multi-program consensus review of values as in the USEPA's Integrated Risk Information System. USEPA does not support use of PPRTVs for purposes other than Superfund. However, in the absence of other chronic health guideline values, this value was used to evaluate the potential public health implications of exposure to iron for this health consultation.

Using the average concentration of iron found in the soil at property D-19, the hazard quotient is below 1.0. This means that adverse health effects from exposure to iron at this property is not likely (see **Table 9**). We reached the same conclusions using the maximum iron concentration in soil.

Table 9. Iron - Noncancer Health Effects - Chronic Exposures

Property	Iron EPC (mg/kg) [a]	Chronic RME dose (mg/kg/day) [b]	Chronic health guideline value (mg/kg/day) [c]	Chronic RME hazard quotient [d]	Potential for health effects
D-19	Maximum = 57,200	Maximum = 1.1	RfD = 0.7 LOAEL = 1.0 (GI effects)*	Maximum = 1.6	No
D-19	Average = 18,834	Average = 0.36	RfD = 0.7 LOAEL = 1.0 (GI effects)*	Average = 0.51	No

[a] EPC = exposure point concentration derived using the maximum and average concentration; [b] RME = reasonable maximum exposure dose representing above average soil ingestion rates for children ages birth to < 1 year; [c] RfD = USEPA reference dose; LOAEL = lowest observed adverse effect level; [d] Hazard Quotient = chronic RME dose/RfD; *GI effects = gastrointestinal effects (ex. nausea, gastric pain, vomiting, diarrhea, constipation) based on USEPA PPRTV study [USEPA 2006]; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Soil-Pica

Soil-pica hazard quotients were elevated for the following contaminants for at least one preschool age group: arsenic, copper, cadmium, aluminum, vanadium, barium, and antimony. The maximum concentration of each contaminant was used as the EPC to evaluate soil-pica in children. This is because soil-pica behaviors might involve a one-time exposure to the maximum level of contamination. The potential for health effects from soil-pica behavior was based on the maximum pica doses, which were calculated using the exposure parameters mentioned in **Table 4.** These doses were then compared to the applicable health guideline value for acute and intermediate exposures.

Arsenic: Fifteen properties had elevated hazard quotients for soil-pica for at least one age group (see **Table 10**). For two of these properties (C-1 and C-4), the calculated exposure doses were above the level where facial swelling and gastrointestinal effects might occur based on human toxicological studies [ATSDR 2007a]. Children exposed to arsenic in soil at these two properties might experience health effects from short-term (one to three times per week) exposures. However, as previously mentioned, the elevated levels of arsenic at these properties are in an area that is difficult to access. The floodplain area behind these properties is contaminated and will be remediated as part of USEPA's fourth operable unit (OU-4) [USEPA 2021b]. Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas along the floodplain behind their properties. The remaining properties did not have elevated soil-pica hazard quotients for arsenic; therefore, noncancer health effects are not likely.

Table 10. Arsenic Soil-Pica –Noncancer Health Effects – Acute Exposures

Property	Arsenic EPC (mg/kg) [a]	Acute pica dose (mg/kg/day) [b]	Acute health guideline value (mg/kg/day) [c]	Pica hazard quotient [d]	One-time dose (mg/kg/day) *	One-time hazard quotient *	Potential for health effects
C-4	1330	0.150	MRL = 0.005 LOAEL = 0.05	30	0.05	10	**Yes ****
C-1	520	0.059	MRL = 0.005 LOAEL = 0.05	12	0.02	4.0	**Yes ****
C-7	231	0.026	MRL = 0.005 LOAEL = 0.05	5.3	NC	NC	No
C-3	206	0.023	MRL = 0.005 LOAEL = 0.05	4.7	NC	NC	No
C-9	174	0.020	MRL = 0.005 LOAEL = 0.05	4.0	NC	NC	No
C-5	148	0.017	MRL = 0.005 LOAEL = 0.05	3.4	NC	NC	No
C-6	109	0.012	MRL = 0.005 LOAEL = 0.05	2.5	NC	NC	No
B-8	107	0.012	MRL = 0.005 LOAEL = 0.05	2.4	NC	NC	No
D-8	69	0.008	MRL = 0.005 LOAEL = 0.05	1.6	NC	NC	No
D-7	60	0.007	MRL = 0.005 LOAEL = 0.05	1.4	NC	NC	No
B-6	52	0.006	MRL = 0.005 LOAEL = 0.05	1.2	NC	NC	No
D-30	51	0.006	MRL = 0.005 LOAEL = 0.05	1.2	NC	NC	No
D-19	50	0.006	MRL = 0.005 LOAEL = 0.05	1.1	NC	NC	No
D-11	46	0.005	MRL = 0.005 LOAEL = 0.05	1.1	NC	NC	No
D-28	44	0.005	MRL = 0.005 LOAEL = 0.05	1.0	NC	NC	No

[a] EPC = exposure point concentration derived using maximum concentration for each property; [b] Acute pica dose represents children ages 1 to < 2 years; [c] MRL = minimal risk level; LOAEL = lowest observed adverse effect level; [d] Hazard quotient = acute pica dose/acute MRL; **GI effects = Gastrointestinal effects (ex. nausea, vomiting, diarrhea); * represents onetime doses and hazard quotients for properties C-1 and C-4; children with soil-pica behaviors at these properties might experience adverse health effects; NC = not calculated; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Copper: Similar to the acute copper analysis above, the $BMDL_{10}$ of 0.05 mg/kg/day was used to determine the likelihood of harmful health effects for acute pica exposures. Of the 61 properties, 16 had elevated hazard quotients for soil-pica for at least one age group. The calculated exposure doses at these properties were above the level where gastrointestinal effects, such as nausea and vomiting, might occur based on human toxicological studies [ATSDR 2022a]. The maximum detected concentration of copper at only two properties (B-8 and C-7) exceeded the current NJDEP residential soil remediation standard of 3,100 mg/kg. Children with pica behavior exposed to copper in soil at the properties shown in **Table 11** might have experienced health effects from short-term acute (weekly) exposures in the past**.** With the exception of D-4 and D-

13, these properties have since been remediated, thereby preventing current and future exposures.

The maximum detected concentration used as the EPC for properties D-4 and D-13 were below the NJDEP residential soil remediation standard. Therefore, remediation was not considered appropriate under CERCLA. Children at these properties exhibiting pica behavior might experience health effects from short-term exposures. The remaining 45 properties and the Gibbsboro Elementary School did not have elevated soil-pica hazard quotients for copper; therefore, adverse noncancer health effects are not likely.

Table 11. Copper Soil-Pica – Noncancer Health Effects

Property	Copper EPC (mg/kg) [a]	Acute pica dose (mg/kg/day) [b]	Acute health guideline value (mg/kg/day) [c]	Pica hazard quotient [d]	Potential for health effects
C-7	15,100	2.8	MRL = 0.02 $BMDL_{10}$ = 0.05	140	**Yes**
B-8	14,400	2.7	MRL = 0.02 $BMDL_{10}$ = 0.05	135	**Yes**
D-27*	944	0.18	MRL = 0.02 $BMDL_{10}$ = 0.05	9	**Yes**
D-17	550	0.1	MRL = 0.02 $BMDL_{10}$ = 0.05	5	**Yes**
D-4	385	0.073	MRL = 0.02 $BMDL_{10}$ = 0.05	3.7	**Yes**
B-7	367	0.069	MRL = 0.02 $BMDL_{10}$ = 0.05	3.5	**Yes**
C-4 **	309	0.058	MRL = 0.02 $BMDL_{10}$ = 0.05	2.9	**Yes**
B-3	265	0.05	MRL = 0.02 $BMDL_{10}$ = 0.05	2.5	**Yes**
C-1 **	246	0.046	MRL = 0.02 $BMDL_{10}$ = 0.05	2.3	**Yes**
D-16	233	0.044	MRL = 0.02 $BMDL_{10}$ = 0.05	2.2	**Yes**
B-2	159	0.03	MRL = 0.02 $BMDL_{10}$ = 0.05	1.5	**Yes**
D-19	126	0.024	MRL = 0.02 $BMDL_{10}$ = 0.05	1.2	**Yes**
C-9	124	0.023	MRL = 0.02 $BMDL_{10}$ = 0.05	1.2	**Yes**
D-13	124	0.023	MRL = 0.02 $BMDL_{10}$ = 0.05	1.2	**Yes**
D-11	118	0.022	MRL = 0.02 $BMDL_{10}$ = 0.05	1.1	**Yes**
D-25	112	0.021	MRL = 0.02 $BMDL_{10}$ = 0.05	1.1	**Yes**

[a] EPC = exposure point concentration derived using maximum concentration for each property; [b] acute pica dose represents children ages 1 to < 2 years; [c] MRL = minimal risk level; BMDL = Benchmark dose level; [d] Hazard quotient = acute pica dose/ MRL; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day; *This property has two bungalows (D-32 and D-33) at the rear of the property where the contamination was located; **Contamination is located in the floodplain area behind these properties and will be remediated as part of USEPA's fourth operable unit (OU-4). Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas located along the floodplain behind their properties.

Cadmium: Three properties had elevated hazard quotients for cadmium for soil-pica in at least one age group. The pica doses at these properties are below the level (i.e., the LOAEL) where decreased bone density occurred in toxicological studies in rats [ATSDR 2012b]. Therefore, noncancer health effects from exposures to cadmium are not likely for children with soil-pica behaviors at these properties (see **Table 12**).

Table 12. Cadmium Soil-Pica – Noncancer Health Effects – Intermediate Exposures

Property	Cadmium EPC (mg/kg) [a]	Intermediate pica dose (mg/kg/day) [b]	Intermediate health guideline value (mg/kg/day) [c]	Pica hazard quotient [d]	Potential for health effects
B-7	5.3	0.0010	MRL = 0.0005 LOAEL = 0.05**	2.0	No
C-4 *	3.6	0.0007	MRL = 0.0005 LOAEL = 0.05**	1.4	No
D-30	3.5	0.0007	MRL = 0.0005 LOAEL = 0.05**	1.4	No

[a] EPC = exposure point concentration derived using 95% UCL for each property; [b] Intermediate pica dose represents children ages 1 to < 2 years; [c] MRL = minimal risk level; LOAEL = lowest observed adverse effect level; [d] Hazard quotient = intermediate pica dose/MRL; **This LOAEL represents a benchmark dose level for decreased bone density in rats [ATSDR 2012]; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day; *Contamination is located in the floodplain area behind this property and will be remediated as part of USEPA's fourth operable unit (OU-4). Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas located along the floodplain behind this property.

Aluminum: Aluminum is considered to be naturally occurring and not a site-related contaminant [Weston 2015]. According to NJDEP, the average level of aluminum in New Jersey soil is 9,250 mg/kg [NJDEP 2020]. Thirteen properties had elevated hazard quotients for soil-pica for at least one age group. However, the calculated exposure doses at these properties were below the level (i.e., the LOAEL) where neuromotor effects were reported in toxicological studies in mice [ATSDR 2008]. Therefore, adverse health effects are not likely for children with soil-pica behaviors exposed to aluminum in soil at these properties (see **Table 13**).

Table 13. Aluminum Soil Pica – Noncancer Health Effects – Intermediate Exposures

Property	Aluminum EPC (mg/kg) [a]	Intermediate pica Dose (mg/kg/day) [b]	Intermediate health guideline value (mg/kg/day) [c]	Pica hazard quotient [d]	Potential for health effects
C-1 *	9,404	1.8	MRL = 1.0 LOAEL = 130	1.8	No
C-4 *	7,996	1.5	MRL = 1.0 LOAEL = 130	1.5	No
C-9	6,107	1.2	MRL = 1.0 LOAEL = 130	1.2	No
C-13	5,642	1.1	MRL = 1.0 LOAEL = 130	1.1	No
D-2	5,410	1.0	MRL = 1.0 LOAEL = 130	1.0	No
D-5	5,790	1.1	MRL = 1.0 LOAEL = 130	1.1	No

D-8	5,970	1.1	MRL = 1.0 LOAEL = 130	1.1	No
D-10	6,182	1.2	MRL = 1.0 LOAEL = 130	1.2	No
D-20	6,750	1.3	MRL = 1.0 LOAEL = 130	1.3	No
D-21	5,350	1.0	MRL = 1.0 LOAEL = 130	1.0	No
D-24	5,840	1.1	MRL = 1.0 LOAEL = 130	1.1	No
D-25	5,500	1.0	MRL = 1.0 LOAEL = 130	1.0	No
E-10	8,910	1.7	MRL = 1.0 LOAEL = 130	1.7	No

[a] EPC = exposure point concentration derived using 95%UCL or maximum concentration (for less than eight samples) for each property; [b] Intermediate pica dose represents children ages 1 to < 2 years; [c] MRL = minimal risk level; LOAEL = lowest observed adverse effect level; [d] Hazard quotient = intermediate pica dose/MRL; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day; *Contamination is located in the floodplain area behind these properties and will be remediated as part of USEPA's fourth operable unit (OU-4). Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas located along the floodplain behind their properties.

Vanadium: One property had an elevated hazard quotient for soil-pica. The calculated exposure dose at this property is approximately equal to the intermediate MRL. Therefore, adverse health effects from exposures to vanadium in soil for children living at this property with soil-pica behaviors are not likely (see **Table 14**).

Table 14. Vanadium Soil Pica – Noncancer Health Effects -Intermediate Exposures

Property	Vanadium EPC (mg/kg) [a]	Intermediate pica dose (mg/kg/day) [b]	Pica hazard quotient [c]	Intermediate health guideline value (mg/kg/day) [d]	Potential for health effects
D-19	58	0.012	1.2	MRL = 0.01 NOAEL = 0.12	No

[a] EPC = exposure point concentration derived using maximum concentration (less than eight samples); [b] Intermediate pica dose represents children ages 1 to < 2 years; [c] Hazard quotient = intermediate pica dose/MRL; [d] MRL = minimal risk level; NOAEL = no observed adverse effect level; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Barium: One property (C-1) had an elevated hazard quotient for soil-pica. The calculated exposure dose for this property is approximately 200 times below the level (i.e., the LOAEL) where toxicological studies in rats showed an increase in kidney weights [ATSDR 2007c]. Therefore, adverse health effects are not likely from soil-pica exposures to barium (see **Table 15**).

Table 15. Barium Soil Pica – Noncancer Health Effects – Intermediate Exposures

Property	Barium EPC (mg/kg) [a]	Intermediate pica dose (mg/kg/day) [b]	Intermediate health guideline value (mg/kg/day) [c]	Pica hazard quotient [d]	Potential for health effects
C-1 *	2,923	0.57	MRL = 0.2 LOAEL = 115	2.8	No

[a] EPC = exposure point concentration derived using the 99% UCL, as this statistical test was the best fit for the dataset; [b] Intermediate pica dose represents children ages 1 to < 2 years; [c] MRL = minimal risk level; LOAEL = lowest observed adverse effect level; [d] Hazard quotient = intermediate pica dose/MRL; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day; *Contamination is located in the floodplain area behind this property and will be remediated as part of USEPA's fourth operable unit (OU-4). Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas located along the floodplain behind this property.

Antimony: One property had elevated hazard quotients for soil pica in at least one age group for intermediate (monthly) exposures to antimony in soil. The calculated exposure dose for this property is approximately 500 times below the level (i.e., the LOAEL) where toxicity studies in rats showed decreased serum glucose levels [ATSDR 2017] (See **Table 16**). Therefore, adverse health effects are not likely for children with soil pica behavior exposed to antimony in soil.

Table 16. Antimony Soil Pica – Noncancer Health Effects – Intermediate Exposures

Property	Antimony EPC (mg/kg) [a]	Intermediate pica dose (mg/kg/day) [b]	Intermediate health guideline value (mg/kg/day) [c]	Pica hazard quotient [d]	Potential for health effects
B-2	7	0.0013	MRL = 0.0006 LOAEL = 0.64	2.2	No

[a] EPC = exposure point concentration derived using the 95% UCL; [b] Intermediate pica dose represents children ages 1 to < 2 years; [c] MRL = minimal risk level; LOAEL = lowest observed adverse effect level; [d] Hazard quotient = intermediate pica dose/MRL; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Lead – Evaluating Health Effects

Protecting children from exposure to lead is important for lifelong good health. Even low levels of lead in blood have been shown to negatively affect a child's health. Exposure to lead can seriously harm a child's health and cause well-documented harmful effects, such as:

- Damage to the brain and nervous system
- Slowed growth and development
- Learning and behavior problems
- Hearing and speech problems

Effects of lead exposure can include reduced intelligence, decreased ability to pay attention, and underperformance in school.

The health effects of lead exposure are more harmful to children younger than 6 years of age because their bodies are still developing and growing rapidly. Young children are more likely to be exposed to lead than are older children because they tend to put their hands or other objects, which might be contaminated with lead dust, into their mouths. For more information, visit CDC's [Childhood Lead Poisoning Prevention Program.]

Lead exposures for the residential properties and the Gibbsboro Elementary School were evaluated using the USEPA's IEUBK v2.0 model. This model estimates a plausible distribution of blood lead levels centered on the geometric mean blood lead levels from available exposure information. Blood lead levels are indicators of exposure and are the most widely used index of internal lead body burdens associated with potential health effects.

CDC uses a blood lead reference value of 3.5 µg/dL to identify children with blood lead levels higher than those of most children in the United States[4]. This level is based on the highest 2.5% of children ages 1-5 years in the United States population using the 2015-2018 National Health and Nutrition Examination Survey (NHANES). The NHANES is a population-based survey used to assess the health and nutritional status of adults and children in the United States. The CDC will periodically update the reference level [CDC 2021].

Currently, USEPA Region 2 uses a lead concentration of 200 mg/kg as a screening level to determine whether an additional property-specific risk evaluation is necessary. If the average lead concentration in the top 2 feet of soil exceeds this screening value, the IEUBK model is used to quantify lead exposures and characterize risk. When risks above USEPA thresholds are identified using this model, remediation is performed by targeting individual data points at levels exceeding the current NJDEP RSRS of 400 mg/kg. Additional excavations are performed as needed to ensure the resulting post-remedy property average is at or below 200 mg/kg.

NJDOH evaluated the broad scope of lead exposures in this community, looking at the potential contribution of lead at this site on children's blood lead levels. NJDOH also evaluated this community and its potential for increased child blood lead levels, based on several other risk factors besides soil lead concentrations. Factors associated with the increased risk for higher blood lead levels include:

- Older housing: Homes built before 1978, and especially before 1950
- Living in rental housing
- Poverty
- Minority groups

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[4] In October 2021, CDC updated the blood lead reference value (BLRV) from 5 µg/dL to 3.5 µg/dL. However, lead models are not currently validated for levels below 5 µg/dL. Therefore, ATSDR uses 5 µg/dL in the models in our health evaluations until the updated BLRV of 3.5 µg/dL can be verified by USEPA in their models.

CDC's BLRV (Blood Lead Reference Value) is a screening tool to identify children who have higher levels of lead in their blood compared with most children. The reference value is not health-based and is not a regulatory standard. States independently determine action thresholds based on state laws, regulations, and resource availability. CDC encourages healthcare providers and public health professionals to follow the recommended follow-up actions based on confirmed blood lead levels.

- Children younger than 6 years
- Age of infrastructure such as plumbing
- Living in the Northeastern United States
- Immigrant and refugee populations

This community has many of these factors that make it a higher risk for higher blood lead levels in children. We continue to work collaboratively with USEPA to stop, reduce, and prevent exposure to lead.

Lead exposures associated with children's use of lead contaminated areas were evaluated using USEPA's IEUBK model. This model is designed to predict the probability that children ages 1.0 to 5 years who regularly play in areas with soil lead contamination could be exposed to lead at levels high enough to raise their average blood lead levels above 5 µg/dL. This level is the lowest level for which the IEUBK model is validated. USEPA is currently evaluating whether the model can be validated and used at lower blood lead levels. The primary goal for NJDOH and ATSDR is to reduce exposures to lead as much as possible because there is no safe level for blood lead in children.

Many factors influence lead exposure and uptake, which limits the accuracy of the IEUBK model to predict individual blood lead levels. These include lead bioavailability, individual nutritional status, model limitations, lead exposure risk factors, variable soil intake rates, seasonality, exposure age, and multiple sources of lead exposure.

Per USEPA guidance, average lead levels in surface soils (0-0.5 feet bgs) were used as an input value to calculate the expected children's blood lead levels from incidental ingestion of lead-contaminated soils. The assumptions for the residential exposure scenario for children are as follows:

- Exposure every day to the same soil concentrations
- Exposure to the average soil lead concentration in the area of interest
- Exposure to other sources of lead (air, water, dust, diet, paint, etc.) is consistent with default (or typical) values [USEPA 2021a]

Lead in Residential Surface Soil

Lead was evaluated at 61 residential properties and at the Gibbsboro Elementary School. **Table A-7 in Appendix A** summarizes the lead concentrations in surface soil (0-0.5 feet bgs) at these properties. **Table 17** shows the number of properties and increasing probabilities of children ages 1-5 years having a blood lead level exceeding 5 µg/dL based on average surface soil lead concentrations.

The higher the probability of exceeding 5 µg/dL, the greater the concern for harmful effects in children from lead exposure from soil. Because no safe blood lead level has been identified, the goal is to reduce blood lead levels in children as much as possible. USEPA has posted fact sheets developed by NJDOH on the three Sherwin-Williams websites to inform residents about ways to reduce exposures to lead in soil and on safe gardening. These fact sheets are included in **Appendix E** of this document.

Table 17. Surface Soil Lead Concentrations and Modeled Blood Lead Levels in Children

Average lead concentration range (mg/kg)	Estimated probability (%) of exceeding a blood lead level of 5 µg/dL *	Estimated geometric mean blood lead level (µg/dL) **	Number of properties
ND-99	NA-1.3	NA-1.8	21^
100-199	1.3-5.9	1.8-2.4	17
200-399	6.0-24.9	2.4-3.6	14
400-799	25.1-63.9	3.6-5.9	8
800-1,199	64.0-83.9	5.9-8.0	1
>1,200	> 83.9	> 8.0	1

NA = Not applicable; mg/kg = milligrams of lead per kilogram of soil; µg/dL = micrograms of lead per deciliter of blood; ^ Includes Gibbsboro Elementary School. *The USEPA 's Integrated Exposure Uptake Biokinetic (IEUBK) model is validated using the previous Centers for Disease Control and Prevention's reference level of 5 µg/dL. ** Blood lead levels were calculated using the USEPA's IEUBK model (Windows version 2.0) with default assumptions, with the exception of blood lead levels set to 5µg/dL. The model was run with results displayed as a density curve for ages 12-60 months (1-5 years), with a bioavailability of 0.3 and geometric standard deviation of 1.6.

Twenty-four properties had average lead levels above 200 mg/kg (see **Table 17-A**). Of these properties, 20 have been remediated, minimizing current and future exposures to lead in soil. The floodplain area behind properties C-1 and C-4 will be remediated during operable unit 4. Remediation of the remaining properties in Group D has been completed. Current and future exposures to lead behind properties C-1 and C-4 might occur. However, exposures are unlikely because the areas containing elevated lead are difficult to access. USEPA has informed the residents about the contamination and suggested avoiding these areas until they are remediated as part of operable unit 4 [USEPA 2021b].

Remediation is not planned for property E-10. USEPA determined that the presence of lead at this property was not site-related [Sherwin 2017]. Of the three surface soil samples collected at this property, the one from the back of the property exceeded the NJDEP RSRS of 400 mg/kg for lead. The average lead level on the property is above 200 mg/kg. NJDOH plans to conduct outreach to residents at this property to make them aware of ways to reduce potential lead exposures. USEPA has also posted NJDOH's fact sheets on the Sherwin-Williams website to inform all residents of ways to reduce exposures to lead in soil and on safe gardening practices.

Table 17-A. Properties with Average Lead Concentrations Above 200 mg/kg

Property	Average Lead Concentration (mg/kg)	Remediation status
B-1	202	Complete
B-2	352	Complete
B-3	401	Complete
B-4	249	Complete
B-7	408	Complete
C-1 **	800	Planned - Part of OU-4
C-3 +	757	Vacant – Part of OU-4
C-4 **	1,297	Planned - Part of OU-4
C-5	321	Complete
C-6	375	Complete
C-7	675	Complete
C-9	243	Complete
D-7	283	Complete
D-10	328	Complete
D-11	549	Complete
D-17	274	Complete
D-19	422	Complete
D-20	637	Complete
D-23	331	Complete
D-25	748	Complete
D-27 *	246	Complete
D-28	227	Complete
D-30	306	Complete
E-10	220	Not Planned (not site related)

*****This property (D-27) has two bungalows (D-32 and D-33) at the rear of the property which have been remediated. The main structure is located on the road and does not require remediation. **Contamination is located in the floodplain area behind these properties and will be remediated as part of USEPA's fourth operable unit (OU-4). Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas located along the floodplain behind their properties; + Property C-3 is currently vacant and will be remediated as part of OU-4; mg/kg = milligram chemical per kilogram soil.

Blood Lead Analysis

NJDOH requires every physician, professional registered nurse, and health care facility to screen for lead exposure in all children younger than 6 years of age who come to them for care (New Jersey Public Law 1995, Chapter 328). Lead is a toxic metal that has been used in paints, gasoline, ceramics, solder, batteries, and many other consumer products. In older houses, especially those built before 1950, the main source of childhood lead exposure is dust and chips from lead-based paint.

All children in New Jersey are considered at risk for lead exposure and poisoning because of their developing nervous systems. Therefore, NJDOH recommends that all children should be tested for lead poisoning at ages 12 months and 24 months, as well as any child between ages 3 and 6 years who has never previously been screened. In addition, NJDOH recommends screening any child aged 6 months or older who might be exposed to a known or suspected lead hazard.

Since July 1999, NJDOH has required clinical laboratories to report all blood lead test results to the State. The NJDOH Childhood Lead Poisoning Prevention (CLPP) program maintains a central surveillance database and patient tracking system called LeadTrax. Using LeadTrax, the CLPP program coordinates with local health departments to document, share, and track case management data and environmental intervention activities. The LeadTrax database includes the following information on each laboratory report:

- Patient's identifying information
- Patient's address
- Patient's age at time of blood specimen collection
- Type of screening specimen (venous or capillary)
- Blood lead result in µg/dL

Multiple lead test reports may be received on the same patient. For the purpose of this analysis, each child was counted only once per calendar year. For each child, the highest result among all venous blood specimens during a calendar year was selected. If no venous sample was available for a child in a calendar year, the lowest result among capillary specimens (finger sticks) was selected, because a blood lead test done on a capillary specimen is susceptible to falsely high results.

In May 2021, CDC updated its blood lead reference value to 3.5 µg/dL in response to the Lead Exposure Prevention and Advisory Committee's recommendation made on May 14, 2021 [CDC 2021]. Prior to this, CDC used a reference level of 5 µg/dL [CDC 2021]. The new reference value emphasizes primary prevention. This means controlling or eliminating sources of lead in a child's environment to prevent exposure and triggering targeted public health actions at lower blood lead levels.

In September 2017, New Jersey amended its rules (N.J.A.C. 8:51) to require nurse case management at a single, venous blood lead level of 5 µg/dL or higher. The rule amendment also requires an environmental inspection whenever a child has two venous blood lead levels of 5 - 9 µg/dL taken 1-4 months apart, or a single venous blood lead level of 10 µg/dL or higher. Both actions are performed by a local health department and require a home visit.

Nurse case management includes education, counseling, health and social services assessments, referrals, and monitoring of retesting. Environmental inspections identify lead hazards, order abatement, and ensure that no one occupies the building while abatement work is being performed. Blood lead levels of 45 µg/dL or higher require medical evaluation and treatment.

N.J.A.C. 8:51A requires that children be screened for lead at ages 1 and 2 years. While it is ideal for all children to be tested at both 1 and 2 years of age, at a minimum all children should have at least one blood lead test done before their third birthday. NJDOH's CLPP program uses the age span of 6 to 29 months to capture data on tests that are performed either earlier than the age of 12 months or later than the age of 24 months. This is because not all children are tested exactly at the age of 1 and 2 years.

Blood lead test results between January 1, 2000 through December 31, 2017 were extracted from LeadTrax for children under age 3 living in Gibbsboro and Voorhees Township at the time that blood was collected for lead analysis. Results were summarized for site-impacted areas/neighborhoods and the two townships. The percentages of children under the age of 3 at the time of testing whose blood lead test reached or exceeded five, 10 and 20 µg/dL were computed and compared for the impacted area, the Townships, and the State of New Jersey.

Table 18 presents the percentages of tested children under the age of 3 with blood lead levels equal to or exceeding five, 10 or 20 µg/dL in the site-impacted areas, Voorhees and Gibbsboro, and the State of New Jersey, during the 18-year period 2000-2017. Statewide, 8.9% of tested children in this age range had blood lead levels at or above 5 µg/dL, with lower percentages in Voorhees/Gibbsboro (3.9%) and the site-impacted areas (7.7%).

The 95% confidence intervals in parentheses show that the proportion of children with higher blood lead levels in the impacted area is not notably different than the towns of Voorhees and Gibbsboro or the State of New Jersey.

Table 18. Percent Blood Lead Levels and 95% Confidence Intervals among Children Under Age 3 (2000-2017)

Population	% > 5 µg/dL	% > 10 µg/dL	% > 20 µg/dL
Site-Impacted Area	7.7% (1.2%, 14.2%)	1.5% (0%, 4.5%)	0.5% (0%, 2.2%)
Voorhees/Gibbsboro	3.9% (3.2%, 4.6%)	0.2% (0%, 0.4%)	0.2% (0%, 0.4%)
State of New Jersey	8.9% (8.9%, 8.9%)	1.1% (1.1%,1.1%)	0.2% (0.2%, 0.2%)

µg/dL = micrograms of lead per deciliter of blood

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a class of over 100 different compounds that are found in and formed during incomplete combustion of coal, oil, wood, or other organic substances [ATSDR 1995]. PAHs are commonly found in petroleum-based products, such as coal tar, asphalt, creosote, and roofing tar. In the environment, PAHs are found as complex mixtures of compounds, and many have similar toxicological effects. Because combustion processes produce them, PAHs are widespread in the environment. PAHs have been found to exhibit anti-androgenic[5] properties in human cell cultures and to have caused reproductive effects in mice and rats [ATSDR 1995].

Noncancer adverse health effects associated with PAH exposures have been seen in animals but generally not in humans [ATSDR 1995]. Noncancer effects are usually seen at much higher levels than found in the environment. The main potential concern for PAH exposures is for cancer effects.

The following PAHs were determined to be contaminants of concern for the residential properties:

- Benzo(a)anthracene

[5] Antiandrogenic substances block the action of androgens, the hormones responsible for male characteristics.

- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Carbazole
- Dibenzo(a,h)anthracene
- Phenanthrene

Benzo(a)pyrene is the only PAH found in the residential soil data that has a health guideline for noncancer health effects. The other PAHs were evaluated for cancer risk relative to benzo(a)pyrene. The maximum EPC for benzo(a)pyrene detected in surface soil was used to determine the potential for adverse health effects from PAH exposure.

Property C-8 had the highest EPC for benzo(a)pyrene (4.0 mg/kg). As shown in **Table 19,** the hazard quotient is below 1.0 for benzo(a)pyrene using the maximum RME dose. Based on this evaluation, noncancer adverse health effects associated with exposures from the ingestion of PAH contaminated soil at the residential properties are unlikely.

Table 19. Polycyclic Aromatic Hydrocarbons – Noncancer Health Effects – Property C-8

PAH	Maximum EPC * (mg/kg)	Maximum RME dose (mg/kg/day)	Reference dose (mg/kg/day)	Hazard quotient**	Potential for health effects (noncancer)
Benzo(a)pyrene	4.0	0.0001	0.0003	0.33	No

PAH = polycyclic aromatic hydrocarbon; *EPC = exposure point concentration for property C-8 derived using 95% UCL; **Hazard quotient (HQ) = maximum RME dose/reference dose = 0.0001/ 0.0003 = 0.33; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Cancer Health Effects

NJDOH evaluates the potential for cancer health effects by assessing the excess cancer risk relating to exposure over the background cancer risk. In New Jersey, approximately 45% of women and 47% of men (about 46% overall), will be diagnosed with cancer in their lifetime [NJDOH 2023]. This is referred to as the “background cancer risk.”

The term “excess cancer risk” represents the risk on top of the background cancer risk and is referred to as the Lifetime Excess Cancer Risk, or LECR. An LECR of “one-in-a-million” (1/1,000,000 or 10^{-6} cancer risk) means that if 1,000,000 people are exposed to a cancer-causing substance at a certain level for a specified period of time, then one cancer above the background number of cancers may develop in those 1 million people over the course of their lifetime (considered to be 78 years).

To put the LECR of 10^{-6} in context of New Jersey’s background cancer risk, the number of cancers expected in one million people over their lifetime is 460,000 (46%) in New Jersey. If these one million people are all exposed to a cancer-causing substance for a specific duration, then 460,001 people might develop cancer instead of the expected 460,000 over the course of their lifetime (78 years) [ATSDR 2014]. This is a theoretical estimate of cancer risk that ATSDR uses as a tool for deciding whether public health actions are needed to protect health. It is not an actual estimate of cancer cases in a community. This theoretical cancer risk is not a prediction that cancer will occur. NJDOH considers estimated cancer risks of less than one additional cancer case among one million persons exposed as an unlikely increased cancer risk (expressed exponentially as 1×10^{-6}).

According to the United States Department of Health and Human Services (USDHHS), the cancer class of contaminants detected at a site is as follows:

- Known human carcinogen
- Reasonably anticipated to be a carcinogen
- Not classified

Table 20 lists the cancer classification for those contaminants of concern that were identified as carcinogens.

Table 20. Cancer Classification for Carcinogenic COCs

Contaminant of concern	Cancer class	Designating agency
Arsenic	known human carcinogen	USDHHS
Polycyclic aromatic hydrocarbons (PAHs)	reasonably anticipated to be a carcinogen	USDHHS
Dieldrin [b]	probable human carcinogen	USEPA
Aroclor 1260 [c]	reasonably anticipated to be a carcinogen	USDHHS

[a] 4-Nitroanaline was detected in one sample on Property A-1; [b] Dieldrin was detected on two properties in Group A and on four properties in Group C; [c] Aroclor 1260 is a polychlorinated biphenyl (PCB) compound and was detected on three properties in Group C; USDHHS = United States Department of Health and Human Services; USEPA = United States Environmental Protection Agency.

Cancer exposure doses were calculated using the following formula:

$$\textit{Cancer exposure dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW} \times \frac{ED}{AT}$$

Where,

mg/kg/day = milligrams of contaminant per kilogram of body weight per day
C = exposure point concentration of contaminant in soil (mg/kg)
IR = soil ingestion rate (mg/day)
EF = exposure factor representing the site-specific exposure scenario
CF = conversion factor (10^{-6} kg/mg)
ED = exposure duration in years (varies with age and scenario)
AT = averaging time of 78 years
BW = body weight (kg)

The site-specific assumptions and recommended exposure factors used to calculate the LECR are the same as those used to assess noncancer health effects. The LECR was calculated by multiplying the cancer exposure dose by USEPA's cancer slope factor (CSF). The CSF is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies. It is expressed as the inverse of the daily exposure dose: $(mg/kg/day)^{-1}$. LECRs for soil exposures were calculated using the following formula [USEPA 2009]:

LECR = Cancer Exposure Dose x CSF

Where,

CSF = Cancer Slope Factor $(mg/kg/day)^{-1}$

Evaluating Cancer for PAHs

When multiple chemicals in the same class, such as PAHs, have similar toxicological properties, potency equivalency factors can be used to express the chemicals' overall carcinogenicity as a single value [ATSDR 2022b]. ATSDR guidance was used to assess the cancer risks associated with PAHs. Using ATSDR's approach, the cancer potency of carcinogenic PAHs was estimated based on their relative potency with reference to benzo(a)pyrene.

For each of the carcinogenic PAHs, the benzo(a)pyrene equivalence was calculated by multiplying the 95%UCL EPC with the cancer potency equivalence factor. The total benzo(a)pyrene equivalence was then obtained by summing each of the individual benzo(a)pyrene equivalences (see **Table 21**). Based on previously described exposure assumptions, LECRs were calculated by multiplying the exposure dose by the cancer slope factor.

Table 21 summarizes the cancer potency factors and LECRs for property C-8, which had the highest benzo(a)pyrene equivalence for PAHs of concern. This approach was used for all properties where PAHs were detected. The calculated LECR for PAHs at property C-8 is considered to be low. The cancer risk for PAHs would be lower for the other properties.

Table 21. Cancer Potency Factors and LECR for PAHs at Property C-8

Contaminants of Concern	**EPC [a] (mg/kg)**	**Potency factor [b]**	**BaP equiv. [c] (mg/kg)**	**Total BaP equiv. (mg/kg)**	**Exposure dose (mg/kg/day)**	**CSF [d] $(mg/kg/d)^{-1}$**	**Maximum LECR [e]**
Benzo[a]pyrene	4.01	1	4.01	4.54	Calculated in PHAST*	1.7	8.9 E-05
Dibenzo(a,h)anthracene	0.22	2.4	0.528	---------	-----------	-----------	----------

[a] EPC = exposure point concentration derived using 95% UCL; [b] Cancer potency equivalency factor relative to benzo[a]pyrene (BaP) [ATSDR 2022]; [c] Benzo(a)pyrene potency equivalency factor = EPC x potency factor; [d] Cancer slope factor; [e] Lifetime excess cancer risk for 33-year exposure duration;*ATSDR Public Health Assessment Site Tool – doses were calculated for both CTE and RME scenarios; mg/kg = milligram chemical per kilogram soil; mg/kg/day = milligram chemical per kilogram body weight per day.

Evaluating Cancer Risk for All Contaminants on All Properties

The maximum LECRs were calculated using the ATSDR PHAST tool and account for children and adults with average and above average soil ingestion rates where children continue to live as adults in the same house (21 years as a child plus 12 years as an adult). This 33-year exposure duration represents the most conservative scenario.

LECRs were also calculated for other scenarios where children do not live in the same house as adults. In this scenario, the exposure duration for children is 21 years and a separate cancer risk is calculated for adults who live at a house for 33 years. **Appendix D** includes an example of a PHAST spreadsheet and calculations.

Seven properties had cumulative LECRs equal to or greater than one in 10,000 ($1x10^{-4}$) people (see **Table 22**). This is considered to be an increased cancer risk above the background risk of cancer. Except for property C-8, arsenic is the main contaminant contributing to the cancer risk at these properties. For property C-8, arsenic and PAHs are the main contaminants contributing to the increased cancer risk. USEPA has either remediated these properties as part of the September 2015 Record of Decision or plans to remediate them as part of operable unit 4 [USEPA 2021b]. The cumulative LECRs for the remaining properties were less than one in 10,000 people, representing a low cancer risk.

Table 22. Properties with Elevated LECRs

Property	Arsenic EPC (mg/kg) [a]	Maximum LECR [b]	Remediation status
C-1 *	431	9.3×10^{-4}	Planned as part of OU-4
C-3 **	48	1.4×10^{-4}	Planned as part of OU-4/Vacant
C-4 *	282	5.8×10^{-4}	Planned as part of OU-4
C-5	112	2.5×10^{-4}	Complete
C-8	9 (plus PAH EPC of 4.5) ^	1.1×10^{-4}	Complete
C-9	80	1.6×10^{-4}	Complete
D-8	69	1.4×10^{-4}	Complete

[a] EPC = exposure point concentration derived using 95% UCL of the mean or the maximum concentration (for less than 8 samples). The 99% UCL was used for properties C-1, as this statistical test was the best fit for the dataset. The 97.5% UCL was used for property C-5, as this statistical test was the best fit for the dataset; [b] LECR = lifetime excess cancer risk representing worst case scenario where children continue to live in the same house as adults (33-year exposure duration); *Contamination is located in the floodplain behind these properties and will be remediated as part of USEPA's fourth operable unit (OU-4). Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas located along the floodplain behind their properties; ** Property C-3 is vacant and will be remediated as part of OU-4; ^Arsenic and polycyclic aromatic hydrocarbons (PAHs) are the contaminants contributing to the LECR for property C-8; mg/kg = milligram chemical per kilogram soil.

Properties with Low Cancer Risks and No Expected Noncancer Health Effects

Twenty- six properties (including the Gibbsboro Elementary School) did not have any elevated hazard quotients for contaminants of concern. The average lead levels on these properties also were below the target concentration of 200 mg/kg, derived by the IEUBK model based on a target blood lead level of 5 µg/dL. Therefore, noncancer health effects at these properties would not be expected (See **Table 23**). In addition, LECRs at these properties ranged from two in 1,000,000 (2×10^{-6}) to five in 100,000 (5×10^{-5}) individuals. This is considered to be a low cancer risk and is not a health concern (See **Table 23**).

Properties listed in **Table 23** had all of the following:

- Average surface soil lead levels below 200 mg/kg

- Low cancer risks
- Hazard quotients that did not require additional evaluation to determine the potential for adverse noncancer health effects.

Table 23. Properties with Low Cancer Risks and No Expected Noncancer Health Effects

Property	Maximum cancer risk (LECR)[a]	Potential for noncancer health effects (RME and pica scenario)[b]	Remediation status
A-1	1.5×10^{-5}	No	Complete
A-2	3.3×10^{-5}	No	Not needed
A-3	5.2×10^{-6}	No	Complete
B-5	1.0×10^{-5}	No	Complete
E-7	5.0×10^{-6}	No	Not needed
E-8	5.4×10^{-6}	No	Not needed
E-9	9.8×10^{-6}	No	Not needed
E-11	3.2×10^{-6}	No	Not needed
C-2 *	Not calculated	Not calculated	Complete
C-10	5.0×10^{-5}	No	Complete
C-11	3.2×10^{-5}	No	Complete
C-12	1.9×10^{-5}	No	Complete
C-19	4.0×10^{-6}	No	Not needed
D-1	2.1×10^{-5}	No	Not needed
D-3	2.7×10^{-5}	No	Not needed
D-6	3.2×10^{-5}	No	Complete
D-12	1.8×10^{-5}	No	Complete
D-14	1.8×10^{-5}	No	Not needed
D-15	4.0×10^{-5}	No	Complete
D-18	1.9×10^{-5}	No	Complete
D-22	3.8×10^{-5}	No	Complete
D-24	1.0×10^{-5}	No	Complete
D-26	7.2×10^{-6}	No	Complete
D-29	1.7×10^{-5}	No	Complete
D-31	2.0×10^{-5}	No	Complete
Gibbsboro Elementary School	2.1×10^{-6}	No	Not needed

[a] Lifetime excess cancer risk represents children living as adults in the same house and 33-year duration; [b] RME = Reasonable Maximum Exposure representing above average ingestion rates for children ages birth to < 1 year; Pica = soil-pica behavior in children ages 1 to < 2 years; *Property C-2 was only sampled for lead in surface soil (0-0.5 inches below ground surface).

The following six properties had low cancer risks (less than 1 in 10,000 people or 10^{-4}) and hazard quotients above 1.0, which did not result in the likelihood of noncancer health effects based on toxicological information: B-6, C-13, D-2, D-5, D-9, and D-21. In addition, average lead levels at these properties were below the target level of 200 mg/kg. Therefore, adverse health effects at these additional six properties are not likely.

Properties with a Potential for Health Effects (Cancer and Noncancer)

Exposure doses for children at 16 properties with above average soil ingestion rates (RME) and/or soil-pica behaviors were approaching or exceeding levels where adverse noncancer health effects occurred in toxicological studies for arsenic and copper. Twenty-four properties had average soil lead levels above the target concentration of 200 mg/kg associated with the blood lead level of 5 µg/dL. This includes properties B-1, B-4, C-6, D-7, D-10, D-20, D-23, D-28, D-30, and E-10, where lead was the only exposure concern. Seven properties had elevated cancer risks (See **Tables 24-26**).

Remediation is complete for properties in Groups A, B, C and D, minimizing current and future exposures. Property C-3 is vacant and will be remediated as part of USEPA's fourth operable unit (OU-4) [USEPA 2021b]. Contamination along the floodplain behind properties C-1 and C-4 also will be remediated as part of OU-4. These areas are not easily accessible and USEPA has advised residents to avoid the floodplain area where contamination is present.

Properties D-4 and D-13 contain levels of copper that result in an elevated noncancer hazard, based on the conservative soil-pica scenario. The maximum concentration of copper used to estimate pica hazard on these properties were an order of magnitude less than the current NJDEP residential soil remediation standard of 3,100 mg/kg. Consequently, USEPA did not target properties D-4 and D-13 for remedial action. Children with soil-pica behaviors living at these properties might experience adverse health effects from exposures to copper. Therefore, NJDOH provided residents at these properties with information on reducing exposures to soil contaminants.

Three surface soil samples were collected at property E-10 in December 2015. Lead was found at a maximum concentration of 428 mg/kg. This was the only exceedance above the NJDEP RSRS of 400 mg/kg for lead and was determined by USEPA to be an isolated incident that was not site related [Sherwin 2017]. This property is not planned for remediation. However, the average concentration of lead was 220 mg/kg, exceeding the target level of 200 mg/kg established by the IEUBK model. Therefore, there might be a potential for adverse health effects from lead exposures in young children at this property. NJDOH provided residents at this property with information on reducing exposures to soil contaminants.

Table 24. Group B Properties – Possible Health Effects

Property	Elevated LECR [a]	Potential for noncancer health effects (RME scenario) [b]	Potential for noncancer health effects (Pica scenario) [c]	Remediation status	Exposure concerns
B-2	No	No	**Yes (copper)**	Complete	Past
B-3	No	No	**Yes (copper)**	Complete	Past
B-7	No	No	**Yes (copper)**	Complete	Past
B-8	No	**Yes (copper)**	**Yes (copper)**	Complete	Past

[a] LECR = Lifetime excess cancer risk; [b] Reasonable maximum exposure representing children ages birth to <1 year; [c] Pica represents children ages 1 to < 2 years.

Table 25. Group C Properties – Possible Health Effects

Property	Elevated LECR [a]	Potential for Noncancer health effects (RME scenario) [b]	Potential for noncancer health effects (Pica scenario) [c]	Remediation status	Exposure concerns
C-1 *	**Yes (arsenic)**	**Yes (arsenic)**	**Yes (arsenic, copper)**	Planned	Past
C-3	**Yes (arsenic)**	No	No	Vacant	Past
C-4 *	**Yes (arsenic)**	**Yes (arsenic)**	**Yes (arsenic, copper)**	Planned	Past
C-5	**Yes (arsenic)**	No	No	Complete	Past
C-7	No	**Yes (copper)**	**Yes (copper)**	Complete	Past
C-8 **	**Yes (arsenic and PAHs)**	No	No	Complete	Past
C-9	**Yes (arsenic)**	**No**	**Yes (copper)**	Complete	Past

[a] LECR = lifetime excess cancer risk; [b] Reasonable maximum exposure representing children ages birth to <1 year; [c] Pica represents children ages 1 to < 2years; *Contamination is located in the floodplain area behind these properties and will be remediated as part of USEPA's fourth operable unit (OU-4). Residents were made aware of the timeline for cleanup and advised to avoid contaminated areas located along the floodplain behind their properties; ** Arsenic and polycyclic aromatic hydrocarbons (PAHs) are the main contaminants contributing to the elevated LECR at property C-8).

Table 26. Group D Properties – Possible Health Effects

Property	Elevated LECR [a]	Potential for noncancer health effects (RME scenario) [b]	Potential for noncancer health effects (Pica scenario) [c]	Remediation status	Exposure concerns
D-4	No	No	**Yes (copper)**	Not planned	Current
D-8	**Yes (arsenic)**	No	No	Complete	Past
D-11	No	No	**Yes (copper)**	Complete	Past
D-13	No	No	**Yes (copper)**	Not planned	Current
D-16	No	No	**Yes (copper)**	Complete	Past
D-17	No	No	**Yes (copper)**	Complete	Past
D-19	No	No	**Yes (copper)**	Complete	Past
D-25	No	No	**Yes (copper)**	Complete	Past
D-27*	No	No	**Yes (copper)**	Complete	Past

[a] LECR = lifetime excess cancer risk; [b] Reasonable maximum exposure representing children ages birth to <1 year; [c] Pica represents children ages 1 to < 2years; *Property D-27 has two lakefront bungalows (D-32 and D-33) at the rear of the property which have been remediated.

Contaminants Not Evaluated for Public Health Implications

Three contaminants, 4-nitrophenol, dibenzofuran, and thallium, were found on the residential properties in surface soil. These contaminants could not be evaluated for public health implications due to the lack of health-based comparison values and toxicity information. 4-nitrophenol was detected at seven properties at a maximum concentration of 0.1 mg/kg. Dibenzofuran was detected at 19 properties at a maximum concentration of 2.0 mg/kg. For all 61 residential properties, thallium was detected in seven out of 611 samples at a maximum concentration of 1.2 mg/kg. Thallium is naturally occurring in New Jersey soils. The mean thallium soil concentration reported by NJDEP is 0.7 mg/kg [NJDEP 2020].

These contaminants were not frequently detected on the residential properties. 4-nitrophenol was detected in 11% of all samples collected and dibenzofuran was found in 29% of all samples. Thallium was detected in only 0.01% of all samples.

Child Health Considerations

ATSDR recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than are adults from certain kinds of exposures to hazardous substances because, on a body weight basis, they eat and breathe more than do adults. Children also play outdoors and often bring food into contaminated areas. They are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can be permanently damaged if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care**.**

NJDOH evaluated the potential risk for children living in the residential area where they might have been exposed to metals in surface soil. Specifically, children ages 1 to 5 years with soil-pica behaviors might experience health effects from exposures to arsenic and copper, depending on where they live (see **Tables 24-26**).

Conclusions

NJDOH and ATSDR have reached the following conclusions for the Sherwin- Williams residential soil contamination:

1. *Current and future exposures to copper and lead in surface soil at three of the 61 residential properties might harm peoples' health.*

Children residing at properties D-4 and D-13 who have soil pica behavior (eating unusually high amounts of soil) might experience gastrointestinal effects (nausea, stomach pain, vomiting) from exposures to copper in soil. Properties D-4 and D-13 contain levels of copper that result in an elevated noncancer hazard based on the conservative soil-pica pathway. The maximum concentrations of copper used to estimate pica hazard on these properties (i.e., 385 mg/kg on D-4 and 124 mg/kg on D-13) are an order of magnitude below the current New Jersey Department of Environmental Protection (NJDEP) residential soil remediation standard of 3,100 mg/kg. Therefore, these properties were not selected for remediation.

Based on three soil samples, property E-10 had average soil lead levels above 200 mg/kg. This is the level at which USEPA's lead model predicts children's blood lead levels could exceed a target of 5 µg/dL, which is used to determine if subsequent remediation is necessary. Although property E-10 has elevated levels of lead, the lead at this property is not considered to be site related. Therefore, this property was not selected for remediation. Exposures to elevated lead levels in soil should be minimized as much as possible. Higher blood lead levels in children may result in attention, learning and behavioral problems. They also might cause decreased hearing and slower growth and development.

2. *Past exposures to arsenic, copper, and lead in surface soil at 27 of the 61 residential properties might have harmed peoples' health.*

Arsenic. The floodplain area of Hilliards Creek, which is owned by the borough, is contaminated. Children with above average soil ingestion rates who frequently accessed that area behind properties C-1 and C-4 might have experienced dermal effects (darkening and thickening of skin) from arsenic exposure. Residents at property C-4 might have experienced facial swelling and gastrointestinal effects from acute (short-term) exposures to arsenic in soil. This is because calculated exposure doses approached or exceeded levels where these health effects were reported in human toxicological studies. Arsenic levels in surface soil at seven properties may result in an increased theoretical cancer risk from exposure. Arsenic levels combined with elevated levels of PAHs may result in an increased theoretical cancer risk at property C-8.

Copper. Children with above average soil ingestion rates living at properties B-8 and C-7 might have experienced gastrointestinal effects (nausea, stomach pain, vomiting) from copper exposure. This is because calculated exposure doses exceeded levels where these effects were seen in human toxicological studies. Children who might have soil-pica behaviors (eating unusually high amounts of soil) living at 14 of these properties might have experienced gastrointestinal health effects from copper exposure. This is because calculated exposure doses exceeded levels where these effects were seen in toxicological studies.

Lead. Average soil lead levels were above 200 mg/kg at 23 of these properties. This is the level at which USEPA's lead model predicts children's blood lead levels could exceed a target of 5 µg/dL, which is used to determine if subsequent remediation is necessary. Higher blood lead levels in children may result in attention, learning, and behavioral problems. They also might cause decreased hearing and slower growth and development.

These 27 properties have been remediated in accordance with USEPA's September 2015 Record of Decision. This minimizes or stops current and future exposures at these properties. Contamination located within the sediments and floodplain soils of Hilliards Creek, which is behind properties C-1 and C-4, will be remediated as part of USEPA's OU-4. The contamination behind properties C-1 and C-4 is not easily accessible. USEPA has informed residents of the contamination and asked that residents avoid these areas. Property C-3 is vacant and will be remediated as part of OU-4.

3. *Past, current, and future exposures to surface soil contaminants at 32 properties, including the Group A properties and the Gibbsboro Elementary School, are not likely to harm people's health.*

Six properties had elevated hazard quotients, but health effects are not likely based on available toxicological information. The remaining 26 properties did not have elevated hazard quotients. All 32 properties had average soil lead levels below 200 mg/kg. All 32 properties also had low cancer risks.

Conclusion Uncertainties

Recent information provided by USEPA indicates that most of the contamination associated with properties in Groups C and D were located along the floodplain area behind the property boundaries and not on the properties themselves. NJDOH and ATSDR acknowledge this new information and that exposures to contaminants may be overestimated in this evaluation.

NJDOH and ATSDR assumed a conservative residential scenario for all properties to account for the possibility that children might have accessed the floodplain area behind their homes at some point in the past. NJDOH and ATSDR acknowledge that these areas are not easily accessible for current and future exposures and will be remediated in the near future as part of the OU-4 cleanup phase [USEPA 2021b].

Recommendations

1. NJDOH and ATSDR recommend that residents with young children at properties D-4, D-13, and E-10 take measures to reduce exposures to copper and lead in soil.

2. NJDOH and ATSDR recommend that residents tell their health care provider if they have been exposed to contaminants under the conditions described in this report. A health care provider can help residents determine whether they need special medical evaluation or increased frequency of tests.

3. The NJDOH and ATSDR recommend that the USEPA continue remediation of the site as described in the September 2021 Record of Decision for Operable Unit 4.

Public Health Action Plan

The purpose of a public health action plan is to ensure that this health consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of NJDOH to follow-up on this plan to ensure that it is implemented. The public health actions to be taken by NJDOH are as follows:

Public Health Actions Taken

NJDOH has:

1. Prepared a public health assessment and two health consultation documents to evaluate the potential public health implications of exposures to site contaminants.

2. Reviewed information provided by USEPA to evaluate the potential health implications of exposures to site contaminants for residents living near the Sherwin-Williams sites as a follow-up to previous NJDOH evaluations.

3. Provided USEPA with NJDOH fact sheets on safe gardening in contaminated soil and on reducing exposures to lead in soil to provide residents with information on reducing exposures. These fact sheets have been posted on USEPA's Sherwin-Williams website. **Copies of these fact sheets are included in Appendix E.**

4. Provided the fact sheets in **Appendix E** to residents at properties D-4, D-13, and E-10 to ensure that they have the knowledge to protect their health by reducing and/or preventing exposures to soil contaminants.

Public Health Actions Planned

NJDOH will:

1. Provide copies of this health consultation to USEPA and to the local health department. This document will also be provided to NJDEP and made available to the public via the city libraries and the NJDOH website.

2. Assist community members in understanding the findings of this report upon request.

3. Continue to review and evaluate data as it is made available.

4. Assist community members with health concerns regarding exposures to site contaminants by providing physician resources to address environmental exposures to hazardous substances.

Report Preparation

The New Jersey Department of Health prepared this health consultation for the Sherwin-Williams site, located in Gibbsboro, Camden County, NJ. This publication was made possible by a cooperative agreement [program #TS20-2001] with the federal Agency for Toxic Substances and Disease Registry (ATSDR). The New Jersey Department of Health evaluated data of known quality using approved methods, policies, and procedures existing at the date of publication. ATSDR reviewed this document and concurs with its findings based on the information presented by the New Jersey Department of Health.

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Appendix A – Figures and Tables

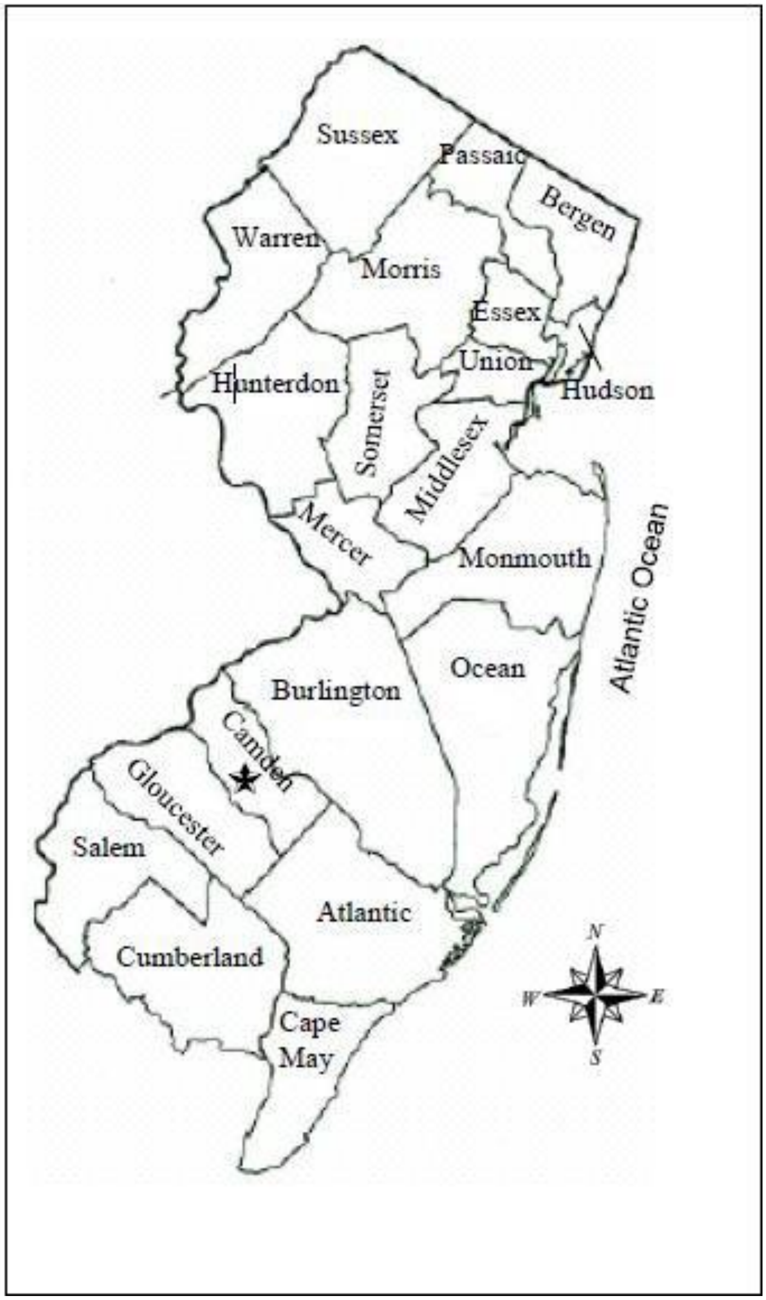


Figure 1. Location of Sherwin-Williams/Hilliards Creek Site

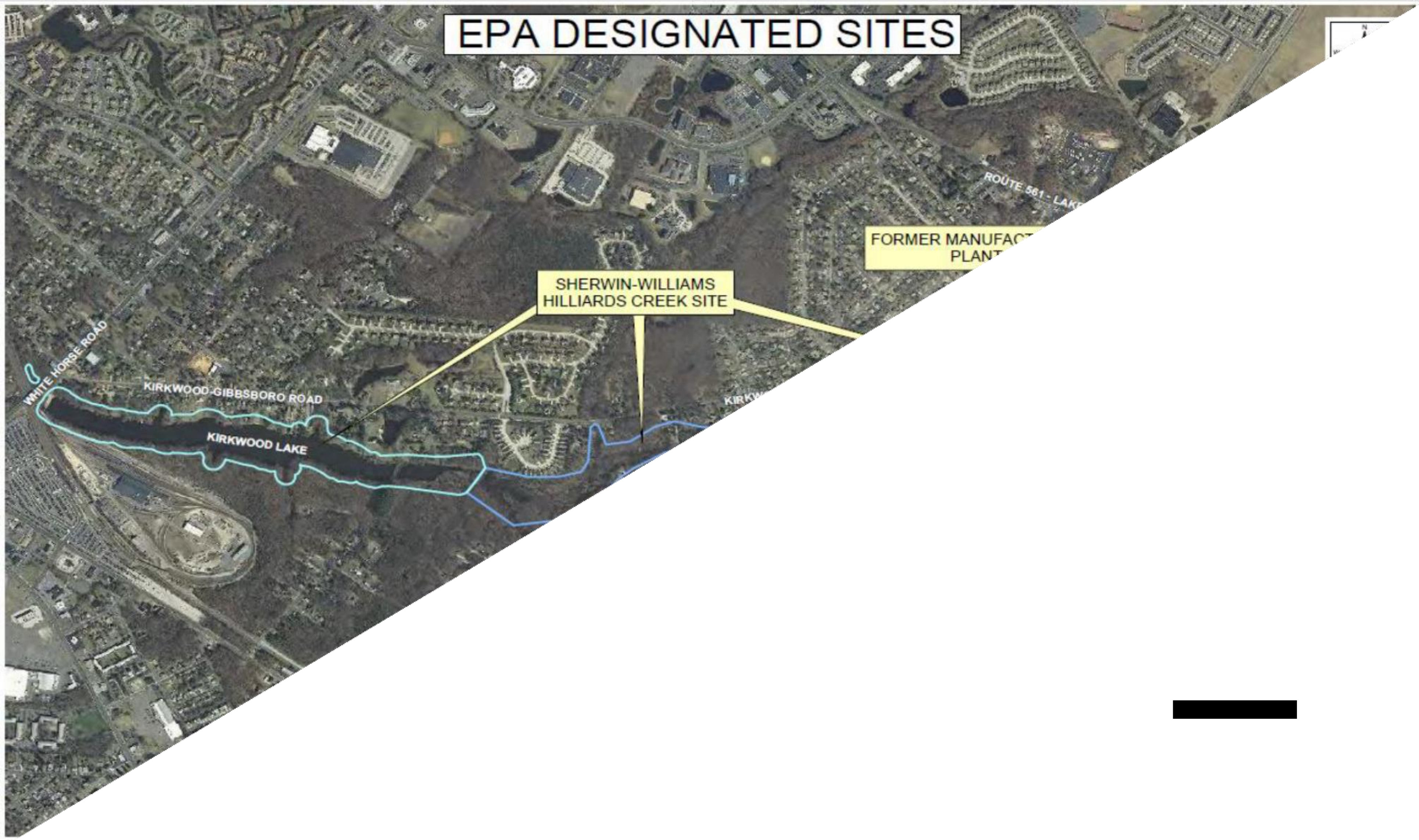


Figure 2. Sherwin-Williams Sites Area Map

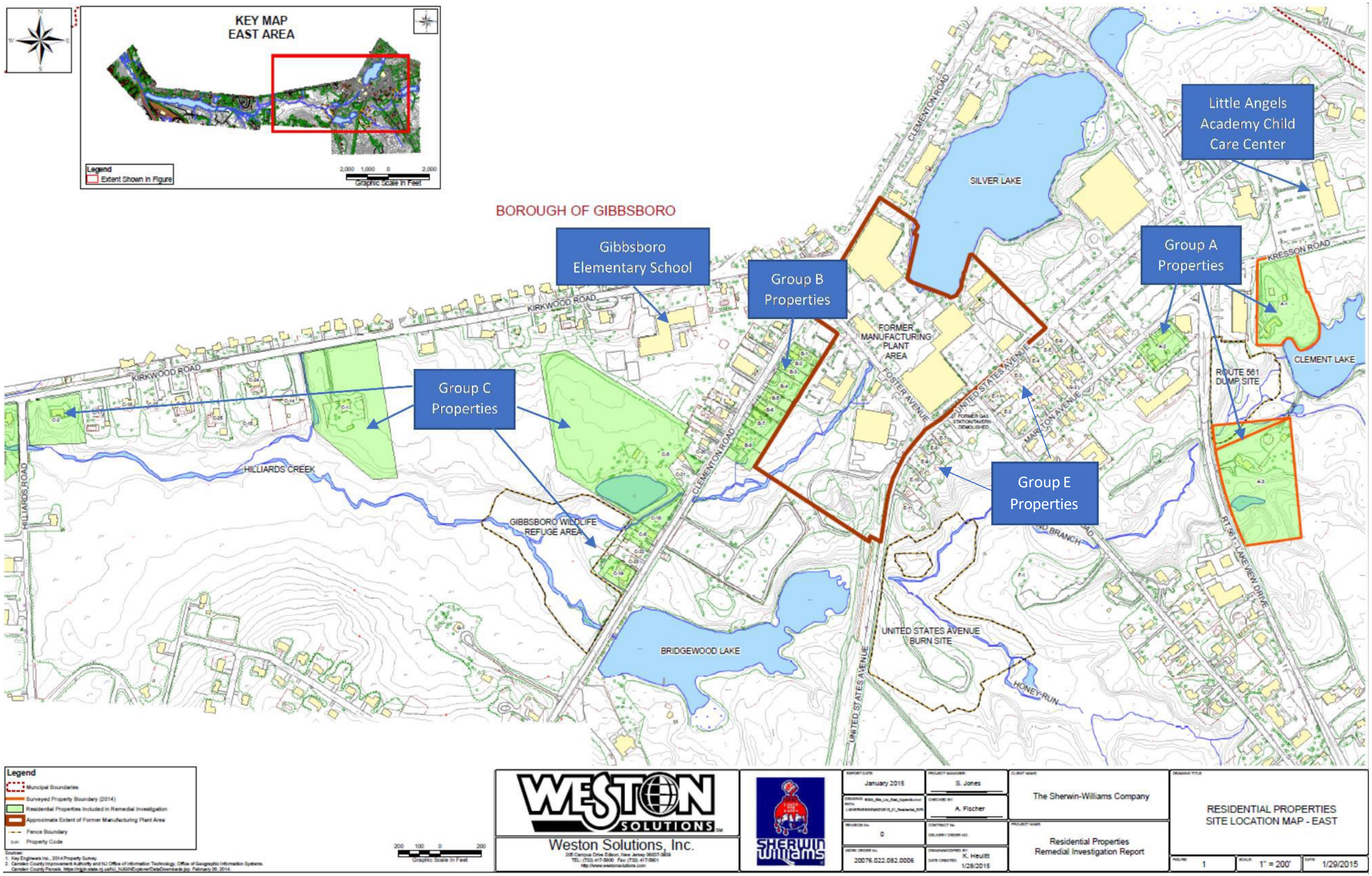


Figure 3. Residential Properties– East (Groups A, B, C, E and Gibbsboro Elementary School)

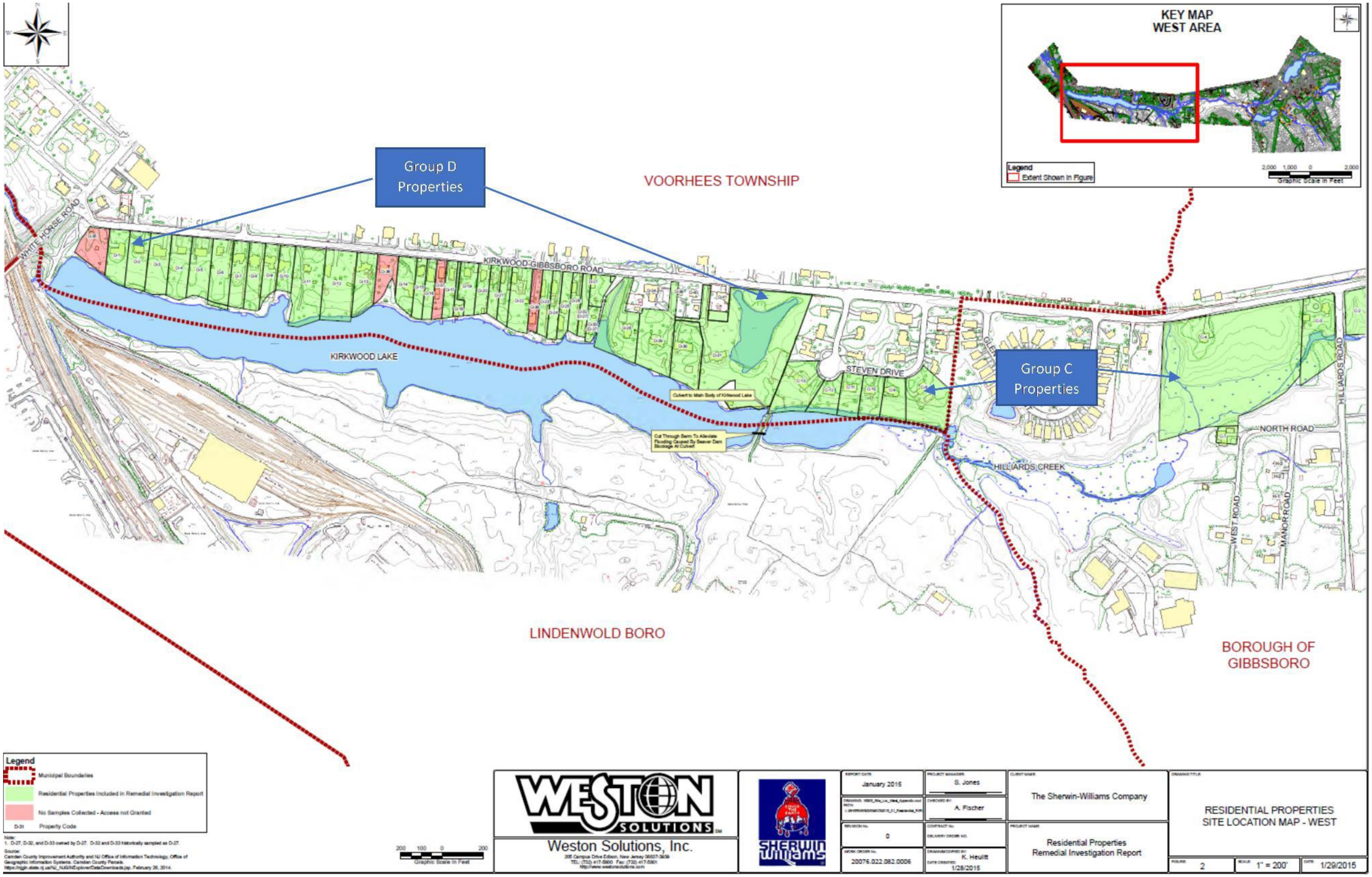


Figure 4. Residential Properties– West (Groups C and D)

Table A-1. Group A Properties Summary – Surface Soil (0-0.5 feet bgs **) – 3 Properties

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Source of Comparison Value*	Selected for Further Evaluation
Metals (Excluding Lead)				
Aluminum	3,720	52,000/5,300	Child EMEG/Pica	No
Antimony	1.3	21/3.2	Child RMEG/Pica	No
Arsenic	16.4	0.26 /27	CREG/Pica	**Yes**
Barium	106	10,000/1,100	Child EMEG/Pica	No
Beryllium	0.31	100	Child EMEG	No
Cadmium	0.64	5.2/2.7	Child EMEG/Pica	No
Chromium (assume Cr III)	39.9	78,000	Child RMEG	No
Cobalt	1.1	520/53	Child Intermediate EMEG/Pica	No
Copper	18.6	1,000/110	Child Intermediate EMEG/Pica	No
Cyanide	9.9	33	Child RMEG	No
Iron	18,400	55,000	USEPA RSL	No
Manganese	218	1,900	NJDEP RSRS	No
Mercury	0.33	23	NJDEP RSRS	No
Nickel	2.9	1,000	Child RMEG	No
Selenium	1.5	260	Child EMEG	No
Silver	0.37	260	Child RMEG	No
Thallium	0.61	Not available	Not available	**Yes**
Vanadium	10.4	520/53	Child Intermediate EMEG/Pica	No
Zinc	84	16,000/1,600	Child EMEG/Pica	No
Pesticides/PCBS				
DDD, P,P'-	0.0028	1.6/2.7	CREG/Pica	No
DDE, P,P'-	0.0098	1.1/2.7	CREG/Pica	No
DDT, P,P'-	0.028	1.1/2.7	CREG/Pica	No
Aldrin	0.0042	0.023/11	CREG/Pica	No
Chlordane (cis and trans)	0.015	0.27	NJDEP RSRS	No
Aroclor 1260	0.18	0.24	USEPA RSL	No
Dieldrin	0.066	0.024/0.53	CREG/Pica	**Yes**
Endrin	0.0093	16/3.2	Child EMEG/Pica	No
Heptachlor epoxide	0.0036	0.043	CREG	No
SVOCs/PAHs				
2-Methylnaphthalene	0.005	2100	Child EMEG	No
4-Methylphenol (p-cresol)	0.005	630	NJDEP RSRS	No
4-Nitroaniline	0.015	Not Available	Not available	**Yes**
Acenaphthene	0.031	3,100/3,200	Child RMEG/Pica	No
Acetophenone	0.038	5,200	Child RMEG	No
Anthracene	0.05	16,000/53,000	Child RMEG/Pica	No
Benzo(a)anthracene	0.17	5.1	NJDEP RSRS	No
Benzo(a)pyrene	0.16	0.065	CREG	**Yes**
Benzo(b)fluoranthene	0.25	5.1	NJDEP RSRS	No
Benzo(g,h,i)perylene	0.031	Not Available	Not Available	**Yes**

Benzo(k)fluoranthene	0.22	51	NJDEP RSRS	No
Bis(2-ethylhexyl) phthalate	0.13	39	NJDEP RSRS	No
Carbazole	0.042	Not Available	Not Available	**Yes**
Chrysene	0.2	510	NJDEP RSRS	No
Dibenzo(a,h)anthracene	0.02	0.11	USEPA RSL	No
Dibenzofuran	0.012	Not Available	Not Available	**Yes**
Di-n-Butyl Phthalate	0.053	5,200/2,700	Child RMEG/Pica	No
Di-n-Octyl Phthalate	0.038	21,000/2,100	Child Intermediate EMEG/ Pica	No
Fluoranthene	0.46	2,100/2,100	Child RMEG/Pica	No
Fluorene	0.021	2,100/2,100	Child RMEG/Pica	No
Indeno(1,2,3-cd) pyrene	0.047	5.1	NJDEP RSRS	No
Naphthalene	0.008	1,000/3,200	Child RMEG/Pica	No
Phenanthrene	0.25	Not Available	Not Available	**Yes**
Phenol	0.015	16,000/5,300	Child RMEG/Pica	No
Pyrene	0.3	1,600	Child RMEG	No

*EMEG = ATSDR environmental media evaluation guide; RMEG = ATSDR reference media evaluation guide; CREG = ATSDR cancer risk evaluation guide; NJDEP RSRS = NJDEP residential soil remediation standard; USEPA RSL= USEPA regional screening level. All values are for chronic exposures unless otherwise stated; pica values are for acute or intermediate exposures; ** bgs = below ground surface; PCBs = polychlorinated biphenyls; SVOCs = semi-volatile organic compounds; PAHs = polycyclic aromatic hydrocarbons; mg/kg = milligram chemical per kilogram soil.

Table A-2. Group B Properties Summary – Surface Soil (0-0.5 feet bgs **) – 8 Properties

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Source of Comparison Value*	Selected for Further Evaluation
Metals (Excluding Lead)				
Aluminum	26,800	52,000/5,300	Child EMEG /Pica	**Yes**
Antimony	25.2	21/3.2	Child RMEG/Pica	**Yes**
Arsenic	107	0.26/27	CREG/Pica	**Yes**
Barium	706	10,000/1,100	Child EMEG/Pica	No
Beryllium	1.32	100	Child EMEG	No
Cadmium	36.6	5.2/2.7	Child EMEG/Pica	**Yes**
Chromium (assume Cr III)	222	78,000	Child RMEG	No
Cobalt	8.2	520/53	Child Intermediate EMEG/Pica	No
Copper	14,400	1,000 110	Child Intermediate EMEG/Pica	**Yes**
Cyanide	12.7	33	Child RMEG	No
Iron	108,000	55,000	USEPA RSL	**Yes**
Manganese	2100	1,900	NJDEP RSRS	**Yes**
Mercury	22.4	23	NJDEP RSRS	No
Nickel	27.9	1,000	Child RMEG	No
Selenium	2.96	260	Child EMEG	No
Silver	1.3	260	Child RMEG	No
Thallium	0.08	Not available	Not available	**Yes**
Vanadium	199	520/53	Child Intermediate EMEG/Pica	**Yes**
Zinc	1310	16,000/1,600	Child EMEG/Pica	No
SVOCs/PAHs				
1,1 Biphenyl	0.052	48	CREG	No
2,4,6-Trichlorophenol	0.0069	35/27	CREG/27	No
2-Methylnaphthalene	0.16	2100	Child EMEG	No
2-Methylphenol (o-cresol)	0.0071	2,600	Child RMEG	No
4-Methylphenol (p-cresol)	0.02	630	NJDEP RSRS	No
4-Nitroaniline	0.19	27	USEPA RSL	No
Acenaphthene	0.33	3,100/3,200	Child RMEG/Pica	No
Acetophenone	0.18	5,200	Child RMEG	No
Anthracene	0.63	16,000/53,000	Child RMEG/Pica	No
Benzaldehyde	0.37	5,200	Child RMEG	No
Benzo(a)anthracene	3	5.1	NJDEP RSRS	No
Benzo(a)pyrene	3.1	0.065	CREG	**Yes**
Benzo(b)fluoranthene	4.5	5.1	NJDEP RSRS	No
Benzo(g,h,i)perylene	2.2	Not Available	Not Available	**Yes**
Benzo(k)fluoranthene	1.7	51	NJDEP RSRS	No
Bis(2-ethylhexyl) phthalate	0.8	39	NJDEP RSRS	No
Butyl benzyl phthalate	0.052	10,000	Child RMEG	No
Carbazole	0.69	Not available	Not available	No
Chrysene	3.6	510	NJDEP RSRS	No
Dibenzo(a,h)anthracene	0.59	0.11	USEPA RSL	**Yes**

Dibenzofuran	0.35	Not available	Not available	**Yes**
Diethyl phthalate	0.02	42,000/32,000	Child RMEG/Pica	No
Di-n-butyl phthalate	0.31	5,200/2,700	Child RMEG/Pica	No
Di-n-octyl phthalate	0.024	21,000/2,100	Child Intermediate EMEG/Pica	No
Fluoranthene	9.4	2,100/2,100	Child RMEG/Pica	No
Fluorene	0.55	2,100/2,100	Child RMEG/Pica	No
Hexachlorobenzene	0.0071	0.24/0.53	CREG/Pica	No
Indeno(1,2,3-cd) pyrene	2.5	5.1	NJDEP RSRS	No
Naphthalene	0.37	1,000/3,200	Child RMEG/Pica	No
Nitrobenzene	0.14	100/110	Child RMEG/Pica	No
Pentachlorophenol	0.0087	0.97/27	CREG/Pica	No
Phenanthrene	5.7	Not available	Not available	**Yes**
Phenol	0.026	16,000/5,300	Child RMEG/Pica	No
Pyrene	7.5	1,600	Child RMEG	No

*EMEG = ATSDR environmental media evaluation guide; RMEG = ATSDR reference media evaluation guide; ATSDR CREG = cancer risk evaluation guide; NJDEP RSRS = NJDEP residential soil remediation standard; USEPA RSL = USEPA regional screening level; All values are for chronic exposures unless otherwise stated; pica values are for acute or intermediate exposures; ** bgs = below ground surface; SVOCs = semi-volatile organic compounds; PAHs = polycyclic aromatic hydrocarbons; mg/kg = milligram chemical per kilogram soil.

Table A-3. Group C Properties Summary – Surface Soil (0-0.5 feet bgs) – 14 Properties**

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Source of Comparison Value*	Selected for Further Evaluation
Metals (Excluding Lead)				
Aluminum	17,800	52,000/5,300	Child EMEG /Pica	**Yes**
Antimony	20.2	21/3.2	Child RMEG/Pica	**Yes**
Arsenic	1,330	0.26/27	CREG/Pica	**Yes**
Barium	3,710	10,000/1,100	Child EMEG/Pica	**Yes**
Beryllium	2	100	Child EMEG	No
Cadmium	18.2	5.2/2.7	Child EMEG/Pica	**Yes**
Chromium (assume Cr III)	1,090	78,000	Child RMEG	No
Cobalt	19.2	520/53	Child Intermediate EMEG/Pica	No
Copper	15,100	1,000/110	Child Intermediate EMEG/Pica	**Yes**
Cyanide	133	33	Child RMEG	**Yes**
Iron	69,700	55,000	USEPA RSL	**Yes**
Manganese	1,350	1,900	NJDEP RSRS	No
Mercury	3.1	23	NJDEP RSRS	No
Nickel	90	1,000	Child RMEG	No
Selenium	5	260	Child EMEG	No
Silver	2.8	260	Child RMEG	No
Thallium	1.2	Not available	Not available	**Yes**
Vanadium	51.3	520/53	Child Intermediate EMEG/Pica	No
Zinc	1,190	16,000/1,600	Child EMEG/Pica	No
Pesticides/PCBs				
4,4'-DDD	0.047	1.6/2.7	CREG/Pica	No
4,4'-DDE	0.31	1.1/2.7	CREG/Pica	No
4,4'-DDT	0.55	1.1/2.7	CREG/Pica	No
Chlordane (cis and trans))	0.0091	0.27	NJDEP RSRS	No
Aroclor-1254	0.14	1.0/0.16	Child EMEG/Pica	No
Aroclor-1260	0.69	0.24	USEPA RSL	**Yes**
BETA-BHC	0.006	0.22/3.2	CREG/Pica	No
Dieldrin	0.055	0.024/0.53	CREG/Pica	**Yes**
Endosulfan I	0.0036	260/27	Child EMEG/Pica	No
Endosulfan sulfate	0.02	380	USEPA RSL	No
Endrin	0.02	16/3.2	Child EMEG/Pica	No
Heptachlor epoxide	0.0019	0.043	CREG	No
SVOCs/PAHs				
1,1 Biphenyl	0.49	48	CREG	No
2-Methylnaphthalene	1.6	2100	Child EMEG	No
4-Chloroaniline	0.006	210	Child RMEG	No
4-Methylphenol (p-cresol)	0.037	630	NJDEP RSRS	No
4-Nitrophenol	0.1	Not available	Not available	**Yes**
Acenaphthene	3.6	3,100/3,200	Child RMEG/Pica	No
Acetophenone	0.016	5,200	Child RMEG	No
Anthracene	4	16,000/53,000	Child RMEG/Pica	No

Benzaldehyde	0.25	5,200	Child RMEG	No
Benzo(a)anthracene	9	5.1	NJDEP RSRS	**Yes**
Benzo(a)pyrene	6	0.065	CREG	**Yes**
Benzo(b)fluoranthene	6.6	5.1	NJDEP RSRS	**Yes**
Benzo(g,h,i)perylene	2.3	Not available	Not available	**Yes**
Benzo(k)fluoranthene	8.3	51	NJDEP RSRS	No
Bis(2-Ethylhexyl) phthalate	5.9	39	NJDEP RSRS	No
Butyl Benzyl Phthalate	0.12	10,000	Child RMEG	No
Caprolactam	0.13	26,000	Child RMEG	No
Carbazole	1.8	Not available	Not available	**Yes**
Chrysene	8.9	510	NJDEP RSRS	No
Dibenzo(a,h)anthracene	1	0.11	USEPA RSL	**Yes**
Dibenzofuran	2	Not available	Not available	**Yes**
Di-n-Butyl Phthalate	0.95	5,200/2,700	Child RMEG/Pica	No
Di-n-Octyl Phthalate	0.74	21,000/2,100	Child Intermediate EMEG/Pica	No
Fluoranthene	24	2,100/2,100	Child RMEG/Pica	No
Fluorene	3.4	2,100/2,100	Child RMEG/Pica	No
Indeno(1,2,3-cd) pyrene	2.9	5.1	NJDEP RSRS	No
Naphthalene	1.1	1,000/3,200	Child RMEG/Pica	No
Pentachlorophenol	0.075	0.97/27	CREG/Pica	No
Phenanthrene	27	Not available	Not available	**Yes**
Phenol	0.012	16,000/5,300	Child RMEG/Pica	No
Pyrene	18	1,600	Child RMEG	No
VOCs				
Acetone	2	31,000/3,200	Child Intermediate EMEG/Pica	No
Toluene	0.002	4,200/1,100	Child RMEG/Pica	No

*EMEG = ATSDR environmental media evaluation guide; RMEG = ATSDR reference media evaluation guide; ATSDR CREG = cancer risk evaluation guide; NJDEP RSRS = NJDEP residential soil remediation standard; USEPA RSL = USEPA regional screening level; All values are for chronic exposures unless otherwise stated; pica values are for acute or intermediate exposures; ** bgs = below ground surface; PCBs = polychlorinated biphenyls; SVOCs = semi-volatile organic compounds; PAHs = polycyclic aromatic hydrocarbons; VOCs = volatile organic compounds; mg/kg = milligram chemical per kilogram soil.

Table A-4. Group D Properties Summary – Surface Soil (0-0.5 feet bgs) – 31 Properties**

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Source of Comparison Value*	Selected for Further Evaluation
Metals (Excluding Lead)				
Aluminum	9,380	52,000/5,300	Child EMEG /Pica	**Yes**
Antimony	3.7	21/3.2	Child RMEG/Pica	**Yes**
Arsenic	69.1	0.26 /27	CREG/Pica	**Yes**
Barium	1720	10,000/1,100	Child EMEG/Pica	**Yes**
Beryllium	1.2	100	Child EMEG	No
Cadmium	4.8	5.2/2.7	Child EMEG/Pica	**Yes**
Chromium (assume Cr III)	123	78,000	Child RMEG	No
Cobalt	5.4	520/53	Child Intermediate EMEG/Pica	No
Copper	944	1,000/110	Child Intermediate EMEG/Pica	**Yes**
Iron	57,200	55,000	USEPA RSL	**Yes**
Manganese	244	1,900	NJDEP RSRS	No
Mercury	6.1	23	NJDEP RSRS	No
Nickel	29.2	1,000	Child RMEG	No
Selenium	2.9	260	Child EMEG	No
Silver	1.8	260	Child RMEG	No
Thallium	0.38	Not available	Not available	**Yes**
Vanadium	57.8	520/53	Child Intermediate EMEG/Pica	**Yes**
Zinc	988	16,000/1,600	Child EMEG/Pica	No
Pesticides/PCBs				
4,4'-DDD	0.14	1.6/2.7	CREG/Pica	No
4,4'-DDE	0.44	1.1/2.7	CREG/Pica	No
4,4'-DDT	0.062	1.1/2.7	CREG/Pica	No
Dieldrin	0.0056	0.024/0.53	CREG/Pica	No
Endosulfan sulfate	0.0036	380	USEPA RSL	No
Endrin	0.012	16/3.2	Child EMEG/Pica	No
Gamma chlordane (trans)	0.0028	0.27	NJDEP RSRS	No
Heptachlor epoxide	0.0024	0.043	CREG	No
SVOCs/PAHs				
2-Methylnaphthalene	0.007	2100	Child EMEG	No
4-Chloro-3-methylphenol	0.021	6,300	USEPA RSL	No
4-Nitrophenol	0.01	Not available	Not available	**Yes**
Acenaphthene	0.011	3,100/3,200	Child RMEG/Pica	No
Acetophenone	0.009	5,200	Child RMEG	No
Anthracene	0.067	16,000/53,000	Child RMEG/Pica	No
Benzaldehyde	0.023	5,200	Child RMEG	No
Benzo(a)anthracene	0.21	5.1	NJDEP RSRS	No
Benzo(a)pyrene	0.19	0.065	CREG	**Yes**
Benzo(b)fluoranthene	0.43	5.1	NJDEP RSRS	No
Benzo(g,h,i)perylene	0.078	Not available	Not available	**Yes**
Benzo(k)fluoranthene	0.36	51	NJDEP RSRS	No
Bis(2-Ethylhexyl) phthalate	0.066	39	NJDEP RSRS	No

Caprolactam	0.014	26,000	Child RMEG	No
Carbazole	0.021	Not available	Not available	**Yes**
Chrysene	0.33	510	NJDEP RSRS	No
Dibenzo(a,h)anthracene	0.067	0.11	USEPA RSL	No
Dibenzofuran	0.007	Not available	Not available	**Yes**
Fluoranthene	0.33	2,100/2,100	Child RMEG/Pica	No
Fluorene	0.014	2,100/2,100	Child RMEG/Pica	No
Indeno(1,2,3-cd) pyrene	0.34	5.1	NJDEP RSRS	No
Naphthalene	0.008	1,000/3,200	Child RMEG/Pica	No
Pentachlorophenol	0.012	0.97/27	CREG/Pica	No
Phenanthrene	0.34	Not available	Not available	**Yes**
Phenol	0.025	16,000/5,300	Child RMEG/Pica	No
Pyrene	0.68	1,600	Child RMEG	No
VOCs				
2-Butanone	0.01	31,000	Child RMEG	No
Acetone	0.22	31,000/3,200	Child Intermediate EMEG/Pica	No
Carbon disulfide	0.005	5,200/53	Child RMEG/Pica	No
Methyl acetate	0.22	78,000	USEPA RSL	No

*EMEG = ATSDR environmental media evaluation guide; RMEG = ATSDR reference media evaluation guide; CREG = ATSDR cancer risk evaluation guide; NJDEP RSRS = NJDEP residential soil remediation standard; USEPA RSL = USEPA regional screening level; All values are for chronic exposures unless otherwise stated; pica values are for acute or intermediate exposures; ** bgs = below ground surface; PCBs = polychlorinated biphenyls; SVOCs = semi-volatile organic compounds; PAHs = polycyclic aromatic hydrocarbons; VOCs = volatile organic compounds; mg/kg = milligram chemical per kilogram soil.

Table A-5. Group E Properties Summary – Surface Soil (0-0.5 feet bgs**) – 5 Properties

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Source of Comparison Value*	Selected for Further Evaluation
Metals (Excluding Lead)				
Aluminum	8,910	52,000/5,300	Child EMEG /Pica	**Yes**
Antimony	0.68	21/3.2	Child RMEG/Pica	No
Arsenic	5.3	0.26/27	CREG/Pica	**Yes**
Barium	834	10,000/1,100	Child EMEG/Pica	No
Beryllium	0.14	100	Child EMEG	No
Cadmium	1.1	5.2/2.7	Child EMEG/Pica	No
Chromium (assume Cr III)	52.1	78,000	Child RMEG	No
Cobalt	1.1	520/53	Child Intermediate EMEG/Pica	No
Copper	45.2	1,000/110	Child Intermediate EMEG/Pica	No
Cyanide	8.5	33	Child RMEG	No
Iron	11,000	55,000	USEPA RSL	No
Manganese	68.4	1,900	NJDEP RSRS	No
Mercury	0.94	23	NJDEP RSRS	No
Nickel	15.6	1,000	Child RMEG	No
Selenium	1	260	Child EMEG	No
Vanadium	18.3	520/53	Child Intermediate EMEG/Pica	No
Zinc	73.3	16,000/1,600	Child EMEG/Pica	No
SVOCs/PAHs				
2-Methylnaphthalene	0.077	2100	Child EMEG	No
4-Methylphenol (p-cresol)	0.0045	630	NJDEP RSRS	No
Acenaphthene	0.0084	3,100/3,200	Child RMEG/Pica	No
Acetophenone	0.021	5,200	Child RMEG	No
Anthracene	0.014	16,000/53,000	Child RMEG/Pica	No
Benzaldehyde	0.028	5,200	Child RMEG	No
Benzo(a)anthracene	0.069	5.1	NJDEP RSRS	No
Benzo(a)pyrene	0.076	0.065	CREG	**Yes**
Benzo(b)fluoranthene	0.11	5.1	NJDEP RSRS	No
Benzo(g,h,i)perylene	0.042	Not available	Not available	**Yes**
Benzo(k)fluoranthene	0.077	51	NJDEP RSRS	No
Butyl benzyl phthalate	0.021	10,000	RMEG Child	No
Caprolactam	0.079	26,000	Child RMEG	No
Carbazole	0.011	Not available	Not available	No
Chrysene	0.097	510	NJDEP RSRS	No
Di-n-Butyl Phthalate	0.014	5,200/2,700	Child RMEG/Pica	No
Di-n-Octyl Phthalate	0.052	21,000/2,100	Child Intermediate EMEG/Pica	No
Fluoranthene	0.18	2,100/2,100	Child RMEG/Pica	No
Fluorene	0.0076	2,100/2,100	Child RMEG/Pica	No
Indeno (1,2,3-cd) pyrene	0.045	5.1	NJDEP RSRS	No
Naphthalene	0.19	1,000/3,200	Child RMEG/Pica	No
Phenanthrene	0.089	Not available	Not available	**Yes**
Pyrene	0.14	1,600	Child RMEG	No

*EMEG = ATSDR environmental media evaluation guide; RMEG = ATSDR reference media evaluation guide; CREG = ATSDR cancer risk evaluation guide; NJDEP RSRS = NJDEP residential soil remediation standard; USEPA RSL = USEPA regional screening level; All values are for chronic exposures unless otherwise stated; pica values are for acute or intermediate exposures; ** bgs = below ground surface; ; SVOCs = semi-volatile organic compounds; PAHs = polycyclic aromatic hydrocarbons; mg/kg = milligram chemical per kilogram soil.

Table A-6. Gibbsboro Elementary School Summary – Surface Soil (0-0.5 feet bgs)**

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Source of Comparison Value*	Selected for Further Evaluation
Metals (Excluding Lead)				
Aluminum	4,430	52,000/5,300	Child EMEG /Pica	No
Antimony	0.9	21/3.2	Child RMEG/Pica	No
Arsenic	8.7	0.26/27	CREG/Pica	**Yes**
Barium	39.6	10,000/1,100	Child EMEG/Pica	No
Beryllium	0.66	100	Child EMEG	No
Cadmium	0.38	5.2/2.7	Child EMEG/Pica	No
Chromium (assume Cr III)	16.3	78,000	Child RMEG	No
Cobalt	1.7	520/53	Child Intermediate EMEG/Pica	No
Copper	13.2	1,000/110	Child Intermediate EMEG/Pica	No
Cyanide	0.5	33	Child RMEG	No
Iron	18,500	55,000	USEPA RSL	No
Manganese	140	1,900	NJDEP RSRS	No
Mercury	0.12	23	NJDEP RSRS	No
Nickel	6.1	1,000	Child RMEG	No
Selenium	0.56	260	Child EMEG	No
Vanadium	34.9	520/53	Child Intermediate EMEG/Pica	No
Zinc	90.8	16,000/1,600	Child EMEG/Pica	No

*EMEG = ATSDR environmental media evaluation guide; RMEG = ATSDR reference media evaluation guide; CREG = ATSDR cancer risk evaluation guide; NJDEP RSRS = NJDEP residential soil remediation standard ; USEPA RSL = USEPA regional screening level; All values are for chronic exposures unless otherwise stated; pica values are for acute or intermediate exposures; ** bgs = below ground surface; mg/kg = milligram chemical per kilogram soil.

Table A-7. Surface Soil Lead Levels (0-0.5 feet bgs) at Residential Properties and Gibbsboro Elementary School**

Property	Number of Samples	Number of Detections	Maximum Lead Concentration (mg/kg)	Mean Lead Concentration (mg/kg)	USEPA Screening Level* (mg/kg)
A-1	11	11	108	49	200
A-2	7	7	369	147	200
A-3	16	16	277	86	200
B-1	23	23	494	202	200
B-2	26	26	1050	352	200
B-3	24	22	2310	401	200
B-4	27	27	479	249	200
B-5	28	28	281	124	200
B-6	24	24	382	119	200
B-7	41	41	2220	408	200
B-8	42	42	2060	184	200
C-1	23	23	6500	800	200
C-2	3	3	93	76	200
C-3	40	40	2930	757	200
C-4	47	47	33100	1297	200
C-5	20	19	1440	321	200
C-6	14	14	1050	375	200
C-7	14	14	3170	675	200
C-8	17	17	267	107	200
C-9	20	20	1150	243	200
C-10	16	16	218	49	200
C-11	19	19	253	89	200
C-12	16	16	201	54	200
C-13	15	15	114	44	200
C-19	3	3	288	173	200
D-1	8	8	121	75	200
D-2	9	9	190	78	200
D-3	5	5	144	101	200
D-4	9	9	266	103	200
D-5	9	9	54	29	200
D-6	9	9	330	163	200
D-7	8	8	394	283	200
D-8	7	7	179	78	200
D-9	8	8	384	157	200
D-10	8	8	630	328	200
D-11	12	12	1580	549	200
D-12	10	10	594	152	200
D-13	8	8	214	83	200

Property	Number of Samples	Number of Detections	Maximum Lead Concentration (mg/kg)	Mean Lead Concentration (mg/kg)	USEPA Screening Level * (mg/kg)
D-14	7	7	96	51	200
D-15	8	8	332	164	200
D-16	7	7	294	117	200
D-17	5	5	571	274	200
D-18	8	8	85	51	200
D-19	8	8	804	422	200
D-20	8	8	1190	637	200
D-21	8	8	355	116	200
D-22	10	10	662	196	200
D-23	7	7	702	331	200
D-24	7	7	166	72	200
D-25	7	7	3750	748	200
D-26	5	5	136	39	200
D-27	7	7	851	246	200
D-28	8	8	497	227	200
D-29	8	8	120	73	200
D-30	8	8	645	306	200
D-31	14	14	311	81	200
E-7	2	2	98	93	200
E-8	2	2	200	162	200
E-9	3	3	261	180	200
E-10	3	3	428	220	200
E-11	2	2	83	64	200
School	24	24	56	30	200

*This level represents a screening level used by the USEPA to evaluate soil lead levels for further actions. If the maximum or the average lead levels exceed 200 mg/kg, individual samples are identified to determine if they exceed the current NJDEP residential soil remediation standard of 400 mg/kg; ** bgs = below ground surface; mg/kg = milligram chemical per kilogram soil.

Appendix B – Demographic Maps

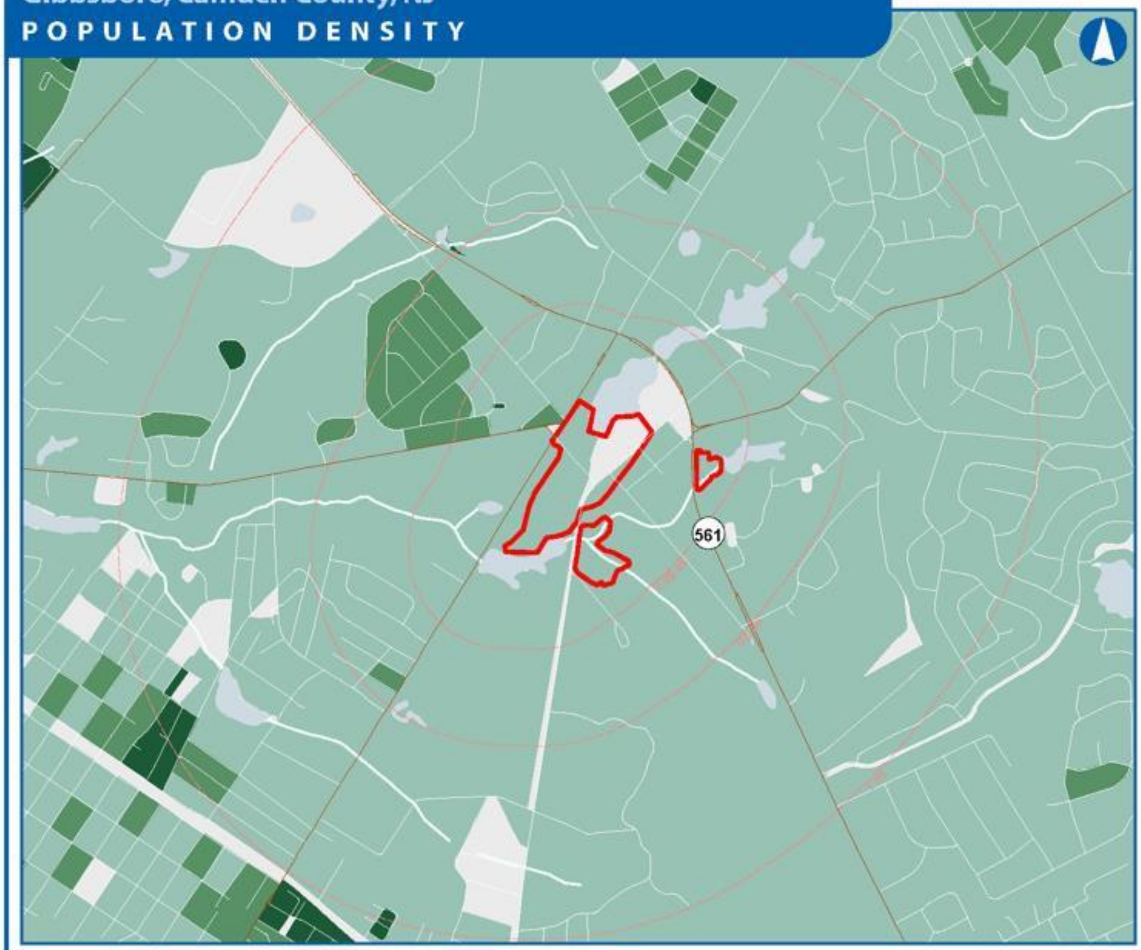
Sherwin Williams/Hilliards Creek

EPA FACILITY ID NJD980417976

INTRODUCTORY MAP SERIES

Gibbsboro, Camden County, NJ

POPULATION DENSITY



The **Population Density Map** depicts the site of interest and the distribution and number of people residing in the surrounding community. The distribution of population in and around a site is critical to understanding a community's potential for exposure to hazardous substances.

Based on US Census 2010 statistics, **199,425** individuals reside within a **5-mile buffer** of the site of interest.

Site of Interest

- Site of Interest[1]
- Site of Interest Buffers[2]

Population Density by Census Block[3] (No. per sq. mi.)

- Zero
- 0 to 5,000
- 5,000 to 10,000
- > 10,000

Healthcare Facilities

- Hospitals[4]
- Urgent Care[5]

Total Population[3,6]

Within specified distance of site boundary

Distance	2000	2010	Change
0.25 mile	597	459	-23%
0.50 mile	1,832	1,727	-5%
1 mile	5,710	6,904	+20%
3 miles[7]	82,000	83,692	+2%
5 miles[7]	198,979	199,425	+0%

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]US Census 2010. [4]Oak Ridge National Laboratory (2013).[5] TomTom International BV (2012).
Notes: [6]Calculated using area-proportion spatial analysis method. [7]Buffer not shown.
Projection: NAD 1983 StatePlane New Jersey FIPS 2900 Feet.

GRASP PRJ ID 05110, 8/23/17

GRASP

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Sherwin Williams/Hilliards Creek

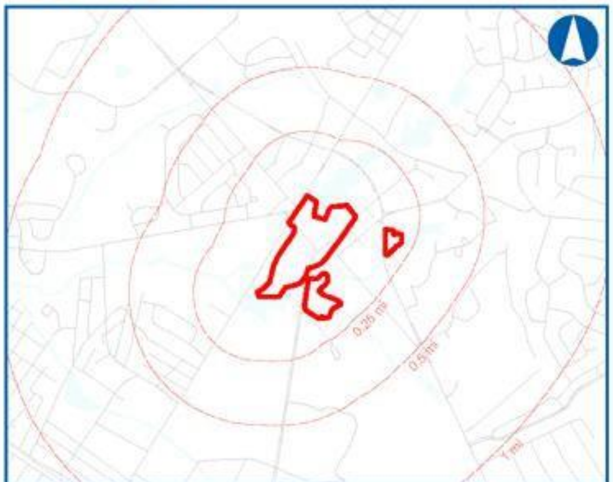
Gibbsboro, Camden County, NJ

GENERAL SITE PROFILE

EPA FACILITY ID NJD980417976

INTRODUCTORY MAP SERIES

Site Vicinity Map



Site of Interest[1] | Site of Interest Buffers[2] | Park[3] | Industrial[3] | Airport[3] | Military Base[3]

The **General Site Profile Map** depicts the hazardous waste site of interest, along with any airport, industrial, military, or park land uses. It also provides community demographic and housing statistics.

Demographic Statistics[4,5]

Within 1 Miles buffer of site boundary

Measure	2000	2010	Change
Total Population	5,710	6,904	+20%
White Alone	4,634	5,418	+16%
Black Alone	631	723	+14%
Am. Indian & Alaska Native Alone	21	11	-47%
Asian Alone	307	479	+56%
Native Hawaiian & Other Pacific Islander Alone	0	1	N/A
Some Other Race Alone	28	93	+232%
Two or More Races	83	179	+115%
Hispanic or Latino[6]	131	326	+148%
Children Aged 6 and Younger	508	438	-13%
Adults Aged 65 and Older	685	1,694	+147%
Females Aged 15 to 44	1,121	1,003	-10%
Housing Units	1,870	2,809	+50%
Housing Units Pre 1950	676	385	-43%

General Population Density

Population Density by Census Block[4] (No. per sq. mi.)

- Zero
- 0 to 5,000
- 5,000 to 10,000
- > 10,000

Sensitive Populations

No. of Children 6 Yrs & Younger by Census Block[4]

- Zero
- 1 to 5
- 6 to 10
- > 10

No. of Adults 65 Yrs & Older by Census Block[4]

- Zero
- 1 to 10
- 11 to 100
- > 100

No. of Females Aged 15 to 44 Yrs by Census Block[4]

- Zero
- 1 to 20
- 21 to 100
- > 100

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]TomTom International BV (2012). [4]US Census 2010. **Notes:** [5]Calculated using area-proportion spatial analysis method. [6]Individuals identifying origin as Hispanic or Latino may be of any race.
Projection: Projection used for all map panels is NAD 1983 StatePlane New Jersey FIPS 2900 Feet.

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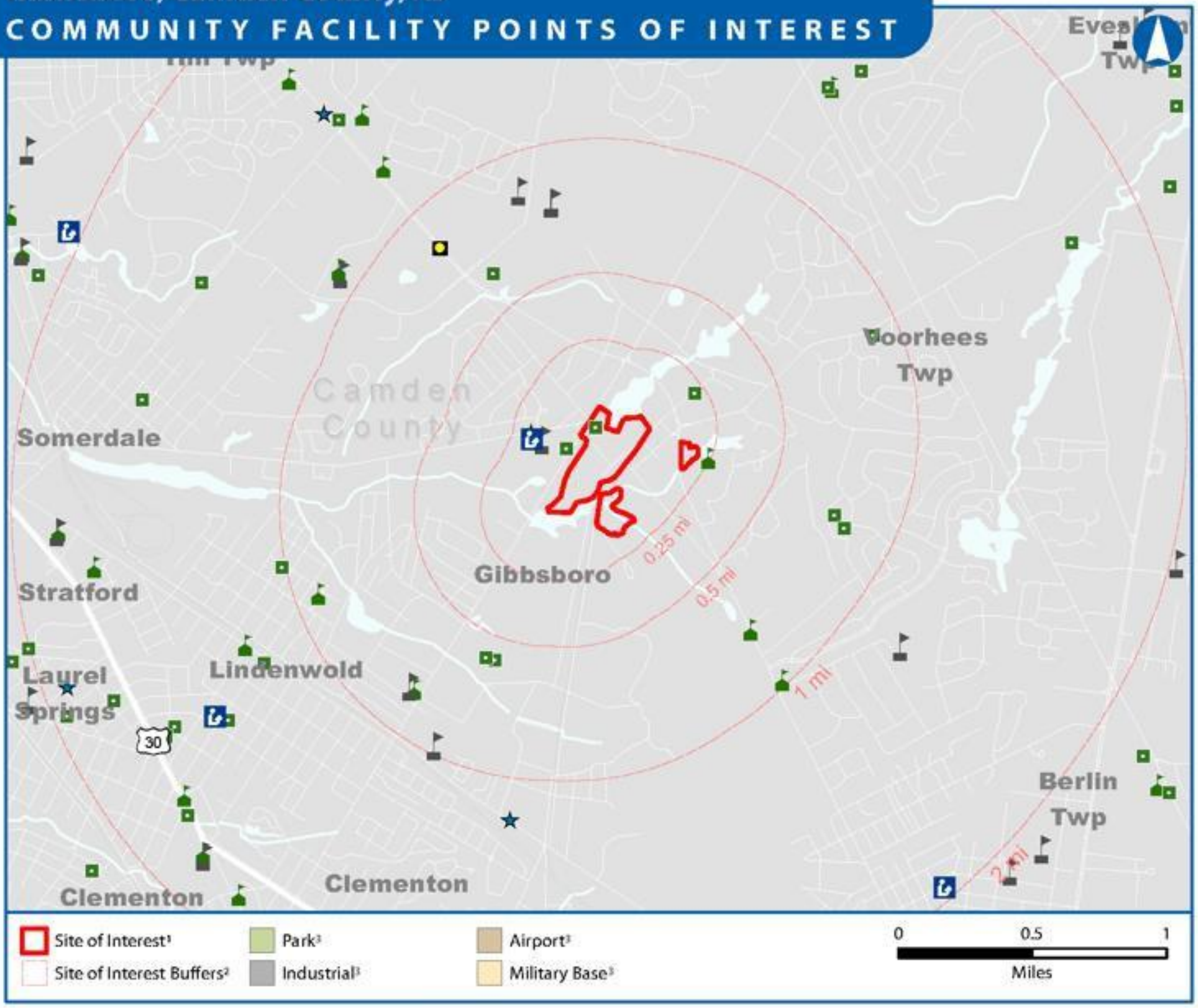
INTRODUCTORY MAP SERIES

Sherwin Williams/Hilliards Creek

Gibbsboro, Camden County, NJ

COMMUNITY FACILITY POINTS OF INTEREST



The **Community Facility Points of Interest Map** depicts the site of interest and community gathering centers in the local area. Information on number, type, and distribution of these facilities is important to efforts to communicate findings to the local population.

Within a **5-mile buffer** of this site are located **359** community gathering centers of which **38%** are designated as places of worship.

Community Facility Points of Interest

Within specified distance of site boundary. Not all buffers may be shown on map.

Facility	0.25 mile	0.5 mile	1 mile	3 miles	5 miles
Libraries[3]	1	1	1	6	10
Schools[4]	1	1	6	33	79
Colleges/Universities[4]	0	0	0	0	2
City Halls[5]	1	1	1	9	13
Civic Centers[3]	0	0	1	1	3
Court Houses[3]	0	0	0	3	5
Places of Worship[3]	3	3	10	67	139
Day Care Centers[4]	1	1	5	44	86
Parks[3]	0	0	0	5	22

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]TomTom International BV (2015). [4]Homeland Security Infrastructure Program 2015. [5]NAVTEQ 2012 Q1 data
Projection: NAD 1983 StatePlane New Jersey FIPS 2900 Feet.

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Appendix C – Brief Summary of ATSDR's Public Health Assessment (PHA) Process

ATSDR follows the PHA process to find out:

- Whether people living near a hazardous waste site are being exposed to toxic substances.
- Whether that exposure is harmful.
- What must be done to stop or reduce exposure.

The PHA process is a step-by-step consistent approach during which ATSDR:

- Establishes communication mechanisms, including engaging communities at the beginning of site activities and involves them throughout the process to respond to their health concerns.
- Collects many different kinds of site information.
- Obtains, compiles, and evaluates the usability and quality of environmental and biological sampling data (and sometimes modeling data) to examine environmental contamination at a site.
- Conducts four main, sequential scientific evaluations.
  - Exposure pathways evaluation to identify past, present, and future site-specific exposure situations, and categorize them as completed, potential, or eliminated.
  - Screening analysis to compare the available sampling data to media-specific environmental screening levels (ATSDR comparison values [CVs] and non-ATSDR screening levels). This identifies potential contaminants of concern that require further evaluation for completed and potential exposure pathways.
  - Exposure Point Concentrations (EPCs) and exposure calculations for contaminants flagged as requiring further evaluation in completed and potential exposure pathways. It involves calculating EPCs, using the estimated EPCs to perform exposure calculations, and determining which site-specific scenarios requires an in-depth toxicological effects analysis.
  - In-depth toxicological effects evaluation, if necessary, based on the three previous scientific evaluations. This step looks more closely at contaminant-specific information in the context of site exposures. This evaluation can also help determine if there is a potential for non-cancer or cancer health effects.

- Summarizes findings and next steps, while acknowledging uncertainties and limitations.
- Provides recommendations to site-related entities, partner agencies, and communities to prevent and minimize harmful exposures.

The sequence of steps can differ based on site-specific factors. For instance, health assessors might define an exposure unit before or after the screening analysis.

For more detail on the PHA process, please visit Explanation of ATSDR's Public Health Assessment Process. Readers can also refer to ATSDR's Public Health Assessment Guidance Manual for all information related to the step-wise PHA process.

Appendix D – PHAST Calculations

The following example dose calculations and PHAST spreadsheets were all from one property (C-1). This property was selected to demonstrate how the risks were calculated for each property evaluated in this health consultation.

The PHAST spreadsheet calculates doses for all age groups for all contaminants of concern. PHAST also calculates the doses for all exposure durations (chronic, intermediate, and acute). It then compares those doses to the appropriate health guideline value if available:

MRL = ATSDR minimal risk level

RfD = USEPA reference dose

CSF = USEPA cancer slope factor

Further evaluation was conducted for contaminants with hazard quotients (HQs) above 1.0 for noncancer health effects. The highest cancer risks for each contaminant at each property were added together to determine the total LECR for each property.

EXAMPLE DOSE CALCULATIONS FROM PHAST:

Contaminant of concern = Arsenic at Property C-1

Exposure Group = Children ages 1 to < 2 years

Table C-1 – Parameters for dose calculations for arsenic at property C-1

Contaminant of concern	EPC (RME) mg/kg	EPC (pica) mg/kg	Intake rate (RME) mg/day	Intake rate (pica) mg/day	ATSDR minimal risk level (MRL) mg/kg/day	Cancer slope factor (CSF) mg/kg/day $^{-1}$
Arsenic	431	520	200	5,000	Chronic = 0.0003 Intermediate = Not Available Acute = 0.005	1.5

EPC = exposure point concentration derived using 95% UCL of the mean or the maximum concentration for soil-pica; mg/kg/day = milligram chemical per kilogram body weight per day; mg/kg = milligram chemical per kilogram soil; mg/day = milligrams of soil ingested per day; RME = reasonable maximum exposure.

Exposure Dose Calculations - Arsenic:

RME dose (above average soil ingestion rates)

Calculations represent children ages 1 to < 2 years

Note: The ingestion dose for arsenic includes a bioavailability factor (BF) of 60% or 0.6. The bioavailability factor for the other contaminants is 100% or 1.0.

Ingestion dose

$$\text{Exposure dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF \times BF}{BW}$$

Where,
mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil = 431 mg/kg;
IR = ingestion rate for children ages 1 to < 2 years = 200 mg/day
EF =exposure factor = 1.0
CF = conversion factor (10^{-6} kg/mg)
BW = body weight = 11.4 kg
BF = bioavailability factor = 60% or 0.6 (only used when calculating arsenic doses)

Substituting values (ingestion dose):

$$\text{Exposure dose} = \frac{431\text{mg/kg} \times 200\text{ mg/day} \times 0.6 \times 1 \times 10^{-6}}{11.4} = \mathbf{0.0045}$$

Dermal dose

$$\text{Dermal exposure dose (mg/kg/day)} = \frac{C \times AF \times EF \times CF \times ABS_d \times SA}{BW \times ABS_{GI}}$$

Where,
mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil = 431 mg/kg;
AF = adherence factor to skin (mg/cm^2-event) = 0.2
EF = exposure factor = 1.0
CF = conversion factor (10^{-6} kg/mg)
ABS_d = dermal absorption fraction to skin = 0.03
SA = skin surface area available for contact = 2,299 cm^2
BW = body weight = 11.4 kg
ABS_{GI} = gastrointestinal absorption factor = 1.0

Substituting values (dermal dose):

$$\text{Dermal exposure dose} = \frac{431 \times 0.2 \times 1.0 \times 10^{-6} \times 0.03 \times 2{,}299}{11.4 \times 1.0} = \mathbf{0.00052}$$

Total RME dose = Ingestion dose + Dermal dose = 0.0045 + 0.00052 = 0.0051 mg/kg/day

$$\text{Chronic hazard quotient (HQ)} = \frac{\text{RME dose} = 0.0051}{\text{Chronic MRL} = 0.0003} = \mathbf{17\ (RME\ HQ)}$$

Note: Calculations may vary slightly due to rounding

Soil-pica dose (applies only to children between ages 1 to < 6 years); used maximum concentration detected on each property as the EPC.

Following the same formulas as above for ingestion and dermal. *The only exception is the pica exposure factor (EF) is 3days/7days = 0.429 and the ingestion rate for pica is 5,000 mg/day*.

The following calculation is for pica children ages 1 to < 2 years.

Substituting values for the pica ingestion and dermal doses:

$$\textbf{Pica ingestion dose} = \frac{520 \times 5{,}000 \times 0.6 \times 0.429 \times 10^{-6}}{11.4} = \mathbf{0.059}$$

$$\textbf{Pica dermal dose} = \frac{520 \times 0.2 \times 1.0 \times 10^{-6} \times 0.03 \times 2{,}299}{11.4 \times 1.0} = \mathbf{0.00063}$$

Total pica dose = 0.059 + 0.00063 = 0.059 mg/kg/day

$$\text{Acute hazard quotient (HQ)} = \frac{\text{Maximum pica dose} = 0.059}{\text{Acute MRL} = 0.005} = \mathbf{12\ (pica\ HQ)}$$

Cancer risk (LECR) – Cancer risks are calculated for all age groups and added to get the total LECR.

Cancer risk (LECR) = Age-Specific Dose x Cancer Slope Factor x Exposure Duration/78 years

Age-specific dose (see formula for RME above) = 0.0051 mg/kg/day
ED = 1 year for children ages 1 to < 2 years for this example (see **Table C-2** below)
AT = averaging time = 78 years (lifetime)
Cancer slope factor (CSF) = 1.5 mg/kg-day^{-1} for arsenic

Substituting values for a child aged 1 to < 2 years (RME scenario):

RME Cancer Exposure Dose (mg/kg/day) = 0.0051 mg/kg/day x $\frac{1 \text{ year}}{78 \text{ years}}$ = 6.5E-05 mg/kg/day

LECR = 6.5E-05 mg/kg/day x 1.5 mg/kg-day $^{-1}$ = 9.8E-05

Table C-2. Age-Specific LECR Calculations for arsenic at property C-1

Cancer Risk by Age Group	RME dose (mg/kg/day)	Exposure duration (ED)	RME cancer exposure dose (mg/kg/day)	Cancer slope factor for arsenic (mg/kg/day) $^{-1}$	RME lifetime excess cancer risk (LECR) for arsenic *
Child - Birth to < 1 year	0.0056	1	7.2E-05	1.5	1.1E-04
Child - 1 to < 2 years	0.0051	1	6.5E-05	1.5	9.8E-05
Child - 2 to < 6 years	0.0034	4	1.7E-04	1.5	2.6E-04
Child - 6 to < 11 years	0.0019	5	1.2E-04	1.5	1.8E-04
Child - 11 to <16 years	0.0007	5	4.5E-05	1.5	6.7E-05
Child - 16 to <21 years	0.00058	5	3.7E-05	1.5	5.6E-05
Combined cancer risk for children exposed for 21 years	----------	21	-----------	--------------	**7.7E-04**
Adult	0.00039	33	1.7E-04	1.5	**2.5E-04**
**Birth to < 21 years + 12 years as an adult ** **	-----------------	----------	-------------	-------------	**8.6E-04**

*LECR results may vary slightly due to rounding; **This LECR is calculated using the following formula: Total LECR = RME adult dose x 12 years/78-year lifetime x cancer slope factor + combined RME LECR for children. This maximum LECR was used to evaluate the cancer risks for each contaminant on each property. RME = reasonable maximum exposure; LECR = lifetime excess cancer risk; mg/kg/day = milligram chemical per kilogram body weight per day; **Bolded** values represent RME cancer risk in **PHAST Table 1** below.

PHAST TABLES – Chronic and Acute Exposures to Arsenic in Soil

Table 1. Residential: Default combined ingestion and dermal exposure doses for chronic exposure to ARSENIC in soil at 431 mg/kg along with noncancer hazard quotients and cancer risk estimates*

PUBLIC HEALTH ASSESSMENT SITE TOOL PHAST Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	CTE Cancer Risk	CTE Exposure Duration for Cancer (yrs)	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	RME Cancer Risk	RME Exposure Duration for Cancer (yrs)
Birth to < 1 year	0.0024	8.0†	-	1	0.0056	19†	-	1
1 to < 2 years	0.0026	8.5†	-	1	0.0051	17†	-	1
2 to < 6 years	0.0013	4.3†	-	4	0.0034	11†	-	4
6 to < 11 years	0.00080	2.7†	-	5	0.0019	6.5†	-	5
11 to < 16 years	0.00038	1.3†	-	1	0.00070	2.3†	-	5
16 to < 21 years	0.00033	1.1†	-	0	0.00058	1.9†	-	5
Total Child	-	-	2.8E-4‡	12	-	-	7.7E-4‡	21
Adult	0.00017	0.55	3.8E-5‡	12	0.00039	1.3†	2.5E-4‡	33
Birth to < 21 years plus 12 years during adulthood§	-	-	-	-	-	-	8.6E-4‡	33

Source: [Weston, 2015]; Abbreviations: CTE = central tendency exposure (typical); mg/kg/day = milligram chemical per kilogram body weight per day; mg/kg = milligram chemical per kilogram soil; RME = reasonable maximum exposure (higher); yrs = years; * The calculations in this table were generated using ATSDR's PHAST v1.6.1.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 0.0003 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 1.5 $(mg/kg/day)^{-1}$. † Indicates the hazard quotient exceeds the noncancer health guideline, which ATSDR evaluates further. ‡ Indicates that the cancer risk exceeds one extra case in a million people similarly exposed, which ATSDR evaluates further.
§ This cancer risk represents a scenario where children are likely to continue to live in their childhood home as adults.

Table 2. Residential: Default combined ingestion and dermal exposure doses for acute exposure to ARSENIC in soil at 520 mg/kg along with noncancer hazard quotients *

PHAST Public Health Assessment Site Tool Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	Soil-Pica Dose (mg/kg/day)	Soil-Pica Noncancer Hazard Quotient
Birth to < 1 year	0.0029	0.58	0.0067	1.3†	-	-
1 to < 2 years	0.0031	0.62	0.0061	1.2†	0.059	12†
2 to < 6 years	0.0015	0.31	0.0041	0.81	0.039	7.8†
6 to < 11 years	0.00096	0.19	0.0023	0.47	-	-
11 to < 16 years	0.00046	0.093	0.00085	0.17	-	-
16 to < 21 years	0.00040	0.079	0.00070	0.14	-	-
Adult	0.00020	0.040	0.00047	0.094	-	-

Source: [Weston, 2015]'Abbreviations: CTE = central tendency exposure (typical); mg/kg/day = milligram chemical per kilogram body weight per day; mg/kg = milligram chemical per kilogram soil; RME = reasonable maximum exposure (higher);* The calculations in this table were generated using ATSDR's PHAST v1.6.1.0. The noncancer hazard quotients were calculated using the acute (less than two weeks) minimal risk level of 0.005 mg/kg/day.

† Indicates the hazard quotient exceeds the noncancer health guideline, which ATSDR evaluates further.

Appendix E – Fact Sheets

Safe Gardening

Reducing Exposures to Lead in Soil

What You Should Know

- **Avoid eating** root vegetables and green, leafy vegetables that have been grown in direct contact with contaminated soil.
  - Examples of root vegetables are carrots, beets, turnips and onions
  - Examples of green leafy vegetables are herbs, lettuce, cabbage, and spinach
- **Before eating** other types of vegetables or fruits that have been grown in direct contact with contaminated soil, ensure that they have been thoroughly washed, and peel them if possible.
  - Examples include tomatoes, squash, peppers, cucumbers, peas, beans, and eggplant

Preparing Fruits and Vegetables

- When washing vegetables, use running water and scrub vegetables well before eating.
- Clean your hands, cutting boards, and kitchen tools with hot, soapy water and rinse well before and after handling your fruits and vegetables.
- Soak garden produce in cool water and rinse thoroughly until the water runs clear.
- Scrub garden produce with a vegetable-cleaning brush to remove dust and dirt before peeling or eating.
- Wash berry fruits like strawberries and blackberries, and remove the "caps" (the tops of the berries where the stern and leaves attach)

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Reducing Your Exposure to Lead in Soil

There is no safe level of lead in the body. Children come into contact with lead when playing outdoors in yards and gardens that have contaminated soil. Exposure to contaminated soil is more dangerous for young children because of their frequent hand-to-mouth activity and their increased susceptibility to lead. Other sources of lead exposure include ingestion of lead-based paint chips and dust, inhalation of lead dust in the air, and ingestion of lead in drinking water. Imported candies, cosmetics, toys, and other products may also contain lead.

Health Effects of Lead

Even low levels of lead in blood may affect a child's ability to pay attention, academic achievement, behavior, and development. Children younger than 6 years are at greatest risk from exposures to lead. Most children with elevated blood lead levels do not exhibit any symptoms, however effects may appear later in age. Other health effects may include kidney damage, anemia, and reductions in birth weight. Symptoms of severely elevated blood lead levels (lead poisoning) may include stomach aches, vomiting, poor appetite, or nausea.

How to Reduce Exposure to Lead in Your Home

- Limit the amount of soil you bring into your home by taking off coats, outerwear, and shoes when entering your home. Place washable rugs at all entries to your home.
- Clean your home weekly to keep it dust free as possible. Clean floors, window sills, doorframes, and baseboards with soap and water. Use a wet mop on hard floors, and clean window sills with wet rags.
- Vacuum carpets and rugs before mopping non-carpeted areas. If possible, use a vacuum with a high-efficiency particulate air (HEPA) filter.
- Wash children's hands frequently, and especially after playing outside, before they eat, and before bedtime. Adults should also wash hands frequently.
- Wash your hands after gardening and before eating or drinking.
- Bathe your pets frequently.

How to Reduce Exposure to Lead When Outdoors

- Avoid eating or drinking while working in the yard or in the garden.
- Dampen soils with water before you garden to limit the amount of dust you inhale.
- Avoid working or playing in the yard on windy days, when dust can be stirred up.
- Keep children and pets away from bare soil areas.
- Have children play in grassy areas or a sandbox that can be covered.

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